ORNAMENTAL LATHE-WORK for Amateurs

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ORNAMENTAL LATHEWORK FOR AMATEURS

Frontispiece.

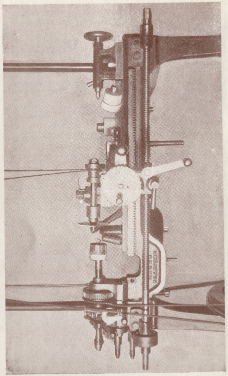

PLATE I.
The Author's Lathe.

ORNAMENTAL LATHEWORK FOR AMATEURS

A PRACTICAL HANDBOOK ON THE EXECUTION OF SIMPLE ORNAMENTAL TURNING AND DECORATIVE INLAYING ON AN ORDINARY LATHE

BY

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PERCIVAL MARSHALL & CO.
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PREFACE.

Ornamental Turning is an exceedingly fascinating and beautiful art, but only enjoyed by the few on account of the costliness of both apparatus and material. Dukes, earls, and retired army men have been amongst its chief workers, but even these are giving it up in many cases—and I state this on the authority of a leading manufacturer of high-class lathe apparatus—on account of their going in for the now prevalent pastime of motoring. But why should should such an art die out? Up to the present such articles as are produced by the ornamental lathe cannot be purchased in the ordinary way, and this fact alone should induce many to make for themselves ornaments that certainly are uncommon.

The object of these chapters is, then, to induce a larger army of hobbyists to enlist in this department of the turner's art, and to give methods, and describe apparatus that can be made at home, whereby the possessor of an ordinary lathe can do splendid work for himself.

Many of the ideas are *original*; others are culled from various sources—which are quoted—and some ideas have been *adapted* to this particular work. If one were confined to ivory and the expensive blackwood, there would be no scope for *this* book, as all that can be said on the subject has been said in the works of J. H. Evans, Sir Thomas Basley,

and others. But it is not so. We have such materials as the hard woods, bone, vegetable ivory, imitation coral, bamboo, and other substances mentioned and treated of in this work. If experts in ivory, etc., turn up their noses at any other than the most expensive materials, then we must conclude that they regard the material, and not the work, as being the more beautiful. But I am uttering a plea for art and skill, and most beautiful results can be secured in such materials as are here mentioned.

One word more. Generally speaking authors forget to specify the cost of things before one starts, and omit to give the names of places and firms where the goods they mention can be purchased. In this case I have endeavoured to give the fullest information. With these assurances we can now proceed to the body of the work.

C. H. C.

NOTE TO PREFACE.

THIS work has been compiled simultaneously with the conducting of the experiments herein defined. This accounts for various methods being given for doing the same thing. Consequently, a variety of courses are open to the worker, from which he can select. As *overlapping of methods* in such variety-work as this is unavoidable, it must be understood that it is difficult to keep each thing distinct, which is responsible for the way in which the matter is put together in this work.

The author has tried to get as much information, and as many suggestions as possible, into a small space, with plenty of illustration.

As this book is intended to "open up" new ground in the realm of turning and decoration, it is desirable that we should know to what extent beginners have been helped, and what difficulties, too, arise in the course of their advancement. To this end we shall gladly receive any letters containing comments, etc., and suggestions from any who can offer them for improvements in any direction in view of any new editions being issued.

A very beautiful subject for an advanced worker would be *an ornamental overmantel*; or another, *an ornamental clock case*. The fascination for this work grows, and it may surprise the reader to know that the writer has only been "at this job" for about nine months and has made all his own apparatus.

BIBLIOGRAPHY.

THE following list of works, from which the author has gained *his* information, is given for the benefit of those desirous of making fuller acquaintance with the advanced stages of the art, and in greater variety than the scope of this work will allow the description of. The materials referred to, however, are of the most expensive kind, and therefore it is more as a question of *manipulation and design* that these will serve to supplement this work.

The books following are given in order relative to their "position" in the realm of lathe ornamentation.

1.—"Simple Decorative Lathe Work." By James Lukin. 2s. Guilbert Pitman.

2.—"Possibilities of Small Lathes." By James Lukin. 1s. 6d. Guilbert Pitman.

3.—"The Lathe and its Uses." By James Lukin. 10s. 6d. Kegan, Paul & Co.

4.—"Ornamental Turning." By J. H. Evans. Three vols., 3s. 6d. each. Guilbert Pitman.

5.—"Polychromatic Turning." By Dr. Audsley. 4s. 6d.

6.—"Lathework." By Paul N. Hasluck. 5s. A useful work, dealing with tool manufacture.

Articles, by Mr. Goldsworthy-Crump, appear in *The Model Engineer* for Nov. 21st, Dec. 12th and 26th, 1907; Jan. 2nd, Feb. 6th, April 2nd, July 18th, Aug. 27th, 1908; July 22nd, Aug. 12th, 1909; June 16th, 1910, dealing with "Ornamental Turning and Tools."

No. 5 deals with a special kind of ornamentation, inasmuch as it leaves out all work done by the various chucks and cutters, and deals exclusively with *the turning and inlaying of various coloured woods* by means of plain hand tools. Studding, also, is one of the sections of the art explained. It is a useful book, and can well be used in conjunction with the rest from the selective point of view.

The work referred to in No. 5, by Dr. Audsley, is also to be obtained in the *English Mechanic* for Feb. 10th, Mar. 3rd and 24th, May 12th, 1911; post free, 10d., though, I think, in an abridged form.

CHAPTER I.

WHAT ORNAMENTAL TURNING IS.

The word "ornamental," as applied to turnery, does not, as many people suppose, refer to any kind of fancy beading placed around a box or table leg, which, though it is ornamental in a sense, is nevertheless called "plain turning." The reason is this: All work, of whatever character, that can be produced by the circular revolution of the material about the axis of the lathe itself, and is operated upon by tools presented to its surface, which cannot be extended to any other than that produced by rotary movement, is called "plain turning." What then does the term "ornamental turning" apply to? Here is the answer. It is the further decoration of an already plain-turned surface by means of various cutters, etc., placed to the work in a state of revolution obtained from another source than the movement of the mandrel, which cutters form designs upon the different surfaces according to the positions they are made to occupy. Ornamental turning then must succeed the plain turning, being dependent upon a prepared and sized-up surface. Some turners call it "engine turning."

The source of power for the driving of these "cutters," as all tools are called in this connection, is the overhead apparatus. It is, however, dependent upon the same source as the lathe in general for its

own power of movement, which means this, that the power generated by means of the treadle movement is directed to the driving of either the lathe proper for the "plain" turning, or the various machines and cutters, while the former is stationary, for the "ornamental turning." Hence it will be clearly seen that what is called an "ornamental lathe" is in reality two machines in one, and self-contained.

All this must be grasped before any attempt can be made to do the work herein described, but it must not be regarded as by any means a difficult thing to do. Once the "principle" is grasped, all avenues to the work in all its branches will be open to the man who will take the trouble to pursue it.

As already hinted in the "Preface," all that follows in these pages is intended to convey the impression that with the addition of a simple overhead to his lathe, and a few home-made tools to be actuated by it, any lathe-man can produce unique and lovely work that will add much value to all his productions in wood and metal. An experienced turner of over fifty years' knowledge and practice of the art remarked to the author the other day that each man can produce designs which another cannot copy, unless the "settings" are given, a thing which makes this work stand high in the realm of art; and further, this work cannot be done by automatic machines. Every design must be an evolution of the worker's own brains and patience, and the wide range of work possible should serve also as an incentive, inasmuch as anything from the beautifully simple to the simply beautiful can be produced, from the easily drilled patterns executed with the

simple drills in the drill-spindle to the elaborate designs cut by means of such terrible sounding instruments as the epicycloidal cutters and geometric chucks.

The range of work herein dealt with, viz., that done by the drill-spindle, the eccentric cutter, the eccentric chuck, and the makeshift dome chuck is quite sufficient to give rise to many wonderful works of art from the hands of the careful man, and this at very little cost.

But one word more is necessary here. It is needful to say that the drill-spindle is used for all patterns where simple circular penetrations are made, and in some cases recesses, grooves, and flutes or flutings; the eccentric cutter, a tool with a cutter fixed to it, driven at great speed, for flutings or cut patterns of infinite variety, vertical, horizontal or any angle between, and for the production of squares, polygons, or any other multi-sided articles, and for the cutting of small domes and semi-circles, etc.; the eccentric chuck for eccentric work generally—the placing of the work eccentric to the lathe axis—and the extemporised dome-chuck for work that requires all facets to be straight or square. Any intelligent worker will, after having read the work through, made the tools and tried them, come to the conclusion that the ideas given will lead him to an interesting and profitable pastime, which will cause him many a happy hour, and many expressions of admiration from his friends.

While it would be quite possible for the reader to reproduce exactly, or very closely, the various examples of work shown in the plates, they are not

really given for the purpose of being copied, except by way of practice. They serve to illustrate some of the endless designs which can be produced, and the author hopes that they may encourage the reader to produce fresh patterns and designs of his own creation.

CHAPTER II.

MATERIALS FOR USE: WOODS AND METALS.

There is no reason why the worker should not use ivory and blackwood, etc., when he can get these commodities in large quantities and at very small cost; but generally speaking we shall all sigh for such things, and turn with comfort and pleasure to other materials that we *can* get.

Boxwood.—This wood can be got fairly easily, well seasoned and moderately cheap. Many timber yards stock it, and it may also be purchased from some tool shops, and cabinet makers. Turkey box is very clean and sound. It may be well to suggest that box, or other wood, can be got in a cheap way and well-seasoned condition by visits to various second-hand dealers who often have old croquet mallets, dumb-bells, and various other articles made of box. The writer has picked up a great deal of material in this way at practically no cost. And many friends also may be found to possess similar articles which they will be glad to give you to take away.

Cocus wood.—An exceedingly fine, hard, and beautifully grained wood of a deep brown colour, which may be purchased through most hardwood dealers.

Bone.—Shin bones, cleaned, cut up, the marrow scraped out, and the whole put into chloride of lime solu-

tion, will afford material for much exquisite work. If the bone is boiled in milk it will assume a very ivory-like appearance. Bone may also be prepared by hanging in turpentine for a time to extract the fatty substances, which settle to the bottom; or may be cleaned in whiting and water. The best method of chucking this material is to fit in a 4-jaw chuck as centrally as possible, and turn out a true hole in the centre, then fix on to a boxwood plug turned to fit it tightly. In this way it can be treated externally. Serviette rings, boxes, etc., can easily be made; but in the latter case the lids must be made of some other material, unless bone can be secured flat and thick enough to turn the lids. Bone rings, let into either lids or bodies of wooden boxes make very effective ornamentations. In fact a box could be "built up" of rings glued together, upon a long mandrel, of various materials, and, as in the case of a long small diameter box, the boring of a very deep hole would be done away with. Care must be exercised to see that in such a case the "core" or "mandrel" is not glued to the rings, so that it is easily withdrawn. If this mandrel is "chalked" it will hold the work better, but makes it a little difficult to remove.

Imitation coral.—Bone again comes into use here. If the bone is reduced to powder it can be mixed with the white of an egg to which sufficient vermilion red is added to make up a workable paste that can be moulded or worked into interstices in other materials. It sets quite hard, and turns nicely. Say, for example, that a lid is finished in wood, so far as ornamentation goes. This "paste"

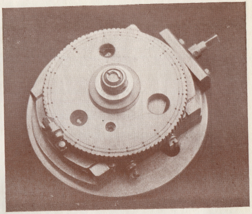


PLATE II.
The Eccentric Chuck.

The actuating screw is seen at top right hand-side and the piece that holds it in position. A collar each side of this—one let in—holds it both ways. The click is the other side. The two adjusting screws are on the under side. The holes in the click-wheel are where the screws went when it was used as a camera fitting, from which it was adapted. The photo is so arranged as to show all the working parts that are external. The drawings in connection with the plate will explain the internal arrangements.

(Facing page 14.)

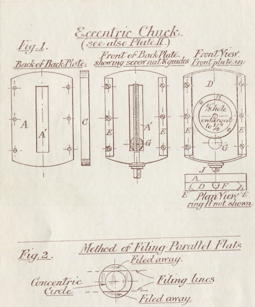


PLATE IIa.
Detail Drawings of Eccentric Chuck. The making of this Chuck is described in Chapter V.

can then be pressed to fill it up, and afterwards carefully faced off. The effect is very fine if the work is clean.

Sealing wax inlays.—Following upon this, another very interesting thing is the working with sealing waxes dissolved in methylated spirit. Applied in exactly the same way as the imitation coral, and afterwards faced off, the effects are very good. Very keen tools must be used, and the work quite set. In the case of wax it must be said that all colours can be got in penny sticks, even to gold and silver ! A very fine sable brush can be used to fill in with, and thus several colors can be applied on the one piece of work, only allowing for one to set before the other is applied to prevent running together. Patterns for this kind of work need to be bold, otherwise fine designs will not show the small details, and the effect would be muddled and certainly not artistic. Let the reader use discretion !

Metals.—The softer kinds of metal do well for ornamentation. White metal, gun metal, brass, copper, etc., can be used together with fine effect. The author has heard of someone making a lady's button hook in the following way :—The handle consisted of a series of rings, or washers, of various metals threaded upon the hook against a shoulder at the hook end, and drawn up tight by means of a screw washer at the other end. These were then turned in position, and the hook finally made. This idea can be extended to various articles. The fly-cutter (afterwards explained) can be used with good effect upon soft metals. The following idea the writer hit upon and has tried

with success. A fairly thick piece of brass was mounted in this way. It was square as it happened. Then, after facing up a piece of boxwood (as elsewhere explained), the brass was warmed over a spirit stove and fixed to the wood-face with turner's cement—a mixture of resin and beeswax. To add strength, two little screws were fixed each side to take any slight extra strain. The disc was then cut circular, and all but through, but not quite. Then it was faced carefully, polished and cleaned, and treated with "Galvanit," which gave it a fine silver face. Through this twelve interlacing circles were cut, not too deeply, nor too shallow. A penetration of about $\frac{1}{64}$ in. to $\frac{1}{32}$ in. was given.

The pattern then showed a gold design set into a silver background. Next the disc was parted off and used as an inlay (see Fig. 3, Plate V), which shows this disc inlaid in boxwood. It may be said that quite a variety of uses may be made of such discs thus treated, not the least useful of them being that of fixing one, fairly deeply cut, on the end of a boxwood handle, to be used as a stamp for sealing wax. I should think—I have not tried this yet—that if a cutting edge were left around the disc, and the pattern cut below this, that seals for inlaying could be made in such materials as wax, etc., by being moulded and cut out in one operation, using a greased stamp.

A box, made of rings of box, bone and cocus, with a lid of cocus inlaid with a brass-plate treated as above, will be quite an ornament without further work, but the rings in turn may be cut in any way desired, and the effect will be very beautiful if properly arranged.

These ideas, it is claimed, will open up a wide field for other experiments, and the ordinary amateur will be able to turn even waste materials to very profitable uses.

It should be very distinctly understood in cutting patterns in brass that the metal will cut more easily, and even cleaner, if the brass is first softened by heating to a dull red and plunging it into salt water. See also that everything is screwed firmly, as there is a tendency to unscrew on the part of the work under certain conditions.

The subject of materials must not be left without a mention of the excellent artificial ivory (vegetable ivory), pure white and dead hard. It can be purchased from some of the fancy wood dealers. The sizes required should be stated when ordering. It works as cleanly and smoothly as anything.

When cutting up ivory nuts be careful to use the little piece left in the chuck. Face off. Cut a design and with narrow parting tool cut the circle round and then remove. Break away the surrounding pieces and place the top, trued end, tightly in a recess in boxwood face chuck, and true down the stem. In this way "waste" pieces can be used up. Further, as these short pieces are tightly wedged in they cannot be removed by any other means than the following:—With parting tool run down to nearly the inserted piece, and when the chuck is only as thick as a shell the tension will give and it will fall out. I finish a host of little trifles in this way and never get a mishap.

A good material is made up of water glass and

pigment of any colour, and works well with care. This can be also treated like the sealing wax, or be used for moulding. The author has been through volumes of *Work* to discover what he remembers once having seen in that paper relative to a substance to be mixed with plaster of Paris, yielding a material that can be turned. He is not certain that he has discovered what he saw, but the following extract may be relative to a similar composition, and is here given—

> "From 4 to 8 per cent. of finely powdered root of the marsh-mallow (*althea officinalis*) mixed with the plaster, is said to render it so hard and tough as to allow it to be turned and polished like ivory; but the setting of the plaster will be retarded for about an hour by the smaller quantity, and for a longer time by a larger percentage." (*Work*, April 30th, 1910). The plaster must be quite *fresh*. Dental plaster is the best quality.

Plating small articles (not with Galvanit) is given in *Work*, September 25th, 1909. "Silver nitrate, $5\frac{1}{4}$ ozs., dissolved in $2\frac{1}{2}$ gallons of water. When dissolved, $8\frac{3}{4}$ ozs. of potassium cyanide are added by stirring and the whole filtered. Use warm or cold. Current is got from a Bunsen battery. Length of immersion determines deposit. The anode consists of either a piece of platinum foil, or a piece of silver."

Bamboo work.—There is a special vertical grain in bamboo that has a beauty of its own. It cuts clean with a keen tool. Of course the surface usual to bamboo is cut away and the "speckled" appearance disappears, but it loses no beauty on that account!

Choice of wood.—Straight, circular, and shakeless bamboo must be selected, and cut into lengths suitable for the work in hand. The "knots" can if

desired, be used for the bottoms of the articles made, or cut off altogether. Being hollow, it must be treated differently from any other kind of wood which has to be hollowed, and therefore if not placed centrally will cause difficulties to arise which will spoil the work. Care and attention must of necessity then be given to the method of chucking and holding the work.

Chucking.—The best method is as follows: Take a selected portion of bamboo and measure the outside diameter. Then cut two pieces of hard wood, and bore with a bit holes of corresponding size. Let the bit just penetrate with its point to give the centre. Next glue on one piece at each end and let dry. Fix up when dry in the usual way—one end to the screw chuck, or to a screw held in the self-centring chuck, and the other end in the back centre. Another method is to true up a piece of box in the lathe till the bamboo will go on just tight, and then glue it, using the solid piece at the knot for the back centre pop, but the first is the better method. Use keen tools to avoid splintering, as this wood readily lends itself to this fault. Having trued up the surface, and given it a polish with a stiff brush slightly charged with yellow wax, proceed to the decoration, but with caution as to the correct kind of work if the result is to be satisfactory.

Decoration of bamboo.—Although fairly round wood can be obtained, it is never positively so, and in consequence the inner irregularities will cause any work, such as is so beautiful with a step drill penetrated through a truly bored cylinder, to become offensive, as parts will disappear or break out where

the bamboo is thinnest. Consequently, if you do penetrating patterns, use plain drills. Surface patterns must also be selected in the same way. Penetration must be shallow and therefore chosen with a view to the general effect, or else the work will be disheartening. Spill-vases, ornaments for table decoration to hold glass tubes for flowers; vases bored through with plain round holes, or other kinds of cut-through designs lined with coloured plush, will make very effective productions. Basket patterns cannot well be worked, except on stiff, thick bamboo, but a very pretty effect can be produced by taking the same kind of cuts right through and leaving every other cut in—that is cutting one and missing one, and also leaving a band between the rows of cuts.

At the draper's one can procure, for next to nothing, old shank pearl buttons, which have a plain face. These are very useful for studding work, and other small decorations. Mother-of-pearl can also be procured in discs. The writer has had some presented to him about 2½ ins. diameter. Interlacing circles cut in this material are exceedingly pretty, but note that the tool is most easily blunted, and care must be used to see that the first cut does not take the point of tool away and render succeeding cuts less deep—a thing which shows more in pearl than in any other material.

African blackwood is in cost the same as cocus, 6d. per lb., but in reality it becomes more expensive, as it is of much larger diameter, and there is more "sap" or outer skin to be got off. Cocus is in size about 3 ins., while the smallest blackwood is about 6 ins. or thereabouts. It is an exceedingly fine wood

to work on, and is, as its name implies, "black" in colour. But at times it has a streak of grey in it which is very pretty. With time and exposure, however, this becomes black.

The writer's first piece of black was only 18 ins. by 5 ins., and cost nearly a sovereign! but that cost was soon met by an order from a friend for six rings at 4/6, which are shewn in one of the plates. This is included to encourage workers to make their hobby *profitable*.

CHAPTER III.

Adapting the Ordinary Lathe to Ornamental Turning.

It may astonish some ordinary lathe men, and perhaps not a few, to be told that simple and effective, which means very beautiful, work can be done on the most ordinary lathe (provided it runs truly) with only such additions as the amateur himself can make from such materials as are to hand in the ordinary workshop.

The present chapter will define and explain these simple equipments.

Stops.—The regularity of depth of cut is maintained each time, not by guess work but by the use of "stops"—small fittings which arrest the forward movement of the tool at a given point. In the case of lateral travel of the tool, say along a cylinder, the use of three stops is necessary—one for penetration, fixed behind, in the cross-slide—and two, one at each end of the top-slide for traverse; these are used in fluting work, etc. If a "Drummond" lathe is in hand the slotted table requires stops made like face-plate dogs, in fact these can be used. In the case of ordinary slide-rest lathes, the stops are made to fit across the slide and to clamp down upon it. The shape can be seen from (Fig. 2, Plate IV). On the author's lathe—a Milnes'—there is a long cross feed,

and in order to cope with work of every kind he has fitted a bar of steel, $\frac{3}{4}$ in. square, to the end at the back and across the screw. Through this is a long screw, turned by a handle. This answers two purposes, firstly to take up the slack in cases where a heavy cut would tend to draw the tool and cause it to dig in. This is a good dodge for any lathe where there is any slack in the nut. The second application is in its use as a cross-slide stop for ornamental work. Even a third use can be made of it, since it can be fixed to gauge repeat work so that the same depth of cut can be set in each time (See Fig 1, Plate IV).

The further need of stops must also be defined. The last described stop, fitted behind the slide-rest, is of no use when cutting circles (face designs) upon eccentric work revolving on the eccentric chuck. For that a stop must be placed *in front*. A very useful means, and I am speaking of the ordinary, not ornamental, rest, is to fit a bar across the carriage with a clamp screw in one end, so that it can slide along the carriage, and clamp in any position. Where any lathe has a slotted carriage any fitting fixed in the slots will effect the same purpose. For stopping the advance of the carriage laterally along the bed, the screw that fixes the hand-rest to the bed can be used, and a washer clamped by its means to the bed firmly. See that the washer is true—a turned one is best—in order that it may bed firmly and not damage the bed surface. When operating the hand-rest temporarily, the slide-rest can be run along towards the tail-poppit out of the way and returned again to the exact position for the next cut. Let it be under-

stood, however, that the use of stops is not required when flutings, etc., pass out clear of the work at each end. With the preceding set of stops the possessor of any ordinary lathe and slide rest can work successfully and do work that will surprise him, and charm him still more.

The drilling spindle (Fig. 3, Plate III).—This tool is essential. Much work can be done with it alone, and it is the first tool to use in the ornamentation of articles in the lathe. It is fixed in the slide rest, and advanced to the work by the top-slide screw. The driving power is from the overhead, which can be made of simple materials ; as, for example, that in use by a model engineer of no mean powers is only a strip of wood upon which are fastened four wheels such as are used in greenhouse lights, the wood being hinged one end and weighted the other to keep the cord tight. Any other can be contrived if this idea is in mind. The cord, if only a single cord is used, is run from the flywheel up to the first pulleys, along to the second pair, over them and down to the spindle, and of course returned. A special length of band will be needed, while that in use ordinarily will for the time being be removed, as the mandrel is stationary. Sometimes, however, a slow motion is required for the mandrel while the drill-spindle tool is operating, or the cutter in the eccentric frame is revolving, and in such cases the mandrel is operated either by hand or by means of the worm screw handle where one is fixed. In Lukin's small work a capital method is given whereby a perfect hemisphere may be formed, viz., by setting the cutter at an angle

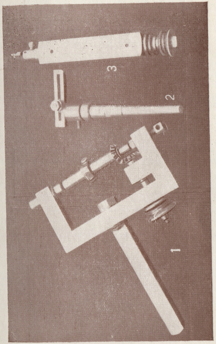


PLATE III.

(1) Universal Cutter Frame. (2) Eccentric Cutter Frame on Taper Fitting to go in large Drilling Spindle (see Plate XI.). (3) Small Drilling Spindle.

(*Facing page 24.*

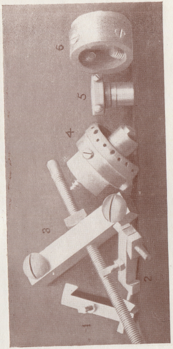


PLATE IV.
Stops and Chucks.

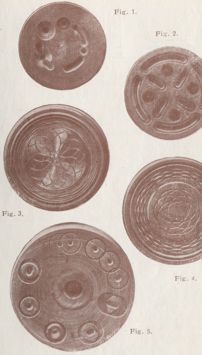


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

PLATE V.
Examples of Patterns produced by Various Tools.
(see Chapter VI)

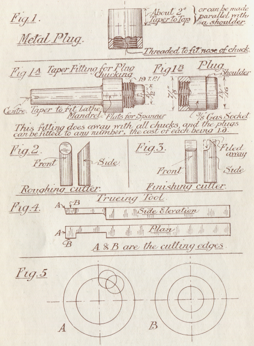


PLATE VI.

Some Accessories and Tools for Ornamental Work (see Chapter IV.).

of 45°, and, while revolving at great speed, slowly advancing it towards the work which itself is slowly rotated by hand. It must be noted, however, that not too deep a cut must be set in. The cut is determined *before* the work is rotated by hand. Then when one revolution is made, advance the cut again and proceed as before, until the perfect hemisphere is produced. Other curves can be got by an alteration in the angular setting of the slide-rest.

In choosing a round belt for the overhead, select "chrome-dressed" twisted leather. This is stronger, wears longer, has more driving power, and what is a real point in its favour, does not jump off the pulleys during work. It is only $1\frac{1}{2}$d. per foot for the $\frac{1}{8}$ in. size. Jumping off seems to be due to the excessive vibration occasioned by speed, but the twisted belt does not seem to be affected as the plain leather is. The tension of the twist may account for this. Anyway, it is worth its mention in this work.

Making a drill-spindle (see note on size of shank in chapter on "Designs").—Mild steel $\frac{3}{4}$ in. square will do, but the proper way is to measure the distance from the top tool rest to the true centre height, and use steel double that distance in section. If $\frac{3}{8}$ in., then $\frac{3}{4}$ in., and so on. Chuck the steel in a 4-jaw chuck and drill through a shade larger than the diameter of spindle revolving in it. See that it runs truly by setting a scriber to the corners. Bore out a larger hole at each end to receive a coned collar—coned inside to 30° and parallel outside to tightly fit this bored hole—and use steel from an old cycle bracket of good quality, softened before being cut and

hardened again after being cut. The front cone on spindle itself should be cut on the spindle, but the back one should be made separately, and made a tight fit to adjust by means of nut when all is put together.

The same steel can be used for the spindle, and can be left unhardened. I make no oil holes in cone but oil in the following way: Partly fill the space in the centre, after placing the spindle in, with oil, and then put in the back cone, and this will run a long time without renewal, and no holes will then be made to let the dirt in. *Too much oil* will fly out over the worker and the work. Before dismissing the drilling spindle, I should like to add that even in the absence of a slide-rest the user can fit his spindle to a sliding socket, fitted in the ordinary T socket, or make a drilling spindle with a push-spindle operated by hand. The drills used are made from flat steel and *shanked* $\frac{1}{8}$ in.

An eccentric cutter.—This tool differs from the drilling spindle inasmuch as the tool revolves at any distance from the centre, within the range of the tool, and cuts circles which are not concentric with the axis of the lathe. It can also cut those that are concentric. It should here be clearly understood that the "eccentric cutter" is not eccentric in itself, for its cutters revolve quite concentrically round their own spindle, but the eccentricity consists solely in its being fixed out of alignment with the true centres of the lathe nose. Hence it follows that by placing the cutter frame with its centre in alignment, nothing eccentric will happen. But with the eccentric chuck—a tool described elsewhere—the nose of the tool holding the

work is thrown out of its own concentricity to any required degree. Practice, however, will soon initiate the novice into the tricks of these useful but curious appliances. Cutters of any suitable shape can be placed in the frame, and revolving at high speed, can be made to cut interlacing circles—which are eccentric or circles within circles which are concentric. (See Fig. 5, Plate VI). Usually the cutter frame is carried on a spindle of its own to which it is made attached, but for economy's sake, we can utilise the drilling spindle to carry it if a socket is made to slip over the end of spindle and is fastened with a set-screw. Fig. 2, Plate III, will describe this cutter frame which can be made from flat strip-brass and soldered and riveted together. It can be made either with a screw to give eccentricity to the tool, or without, in which case the tool can be set to a graduated line, marked in tenths-of-an-inch along the top surface.

A certain amount of work can be done by the drill spindle alone with cranked instead of straight cutters without this latter tool being made at all; but it means such an increase in the manufacture of cutters that no compensation is forthcoming. However, there are times when a tool of the cranked order is preferable, and even necessary, on account of certain work being so placed as to disallow the movement of the eccentric frame. Cranked tools can be made from either flat material of varying widths with the cutter formed on one side and the shank on the other, as shown in Plate VII, or from round material forged to shape and filed up to the correct cutting edge. I prefer the former as easier and more expeditious.

Referring again to the manufacture of the eccentric cutter frame, I ought to say that if the amateur prefers a more efficient tool he should make the screw to actuate the cutter, as in all ordinary tools, as giving less trouble in the settings and ensuring greater accuracy. The cutting edge of the tool must be in the same plane exactly as that of the centre of the frame on which it revolves.

A note should here be added to the effect that in cases where the turner's lathe is not possessed of counting apparatus, and where the change wheels are not accurate enough for division work of fine character, or are too limited, the count-wheel, on the eccentric chuck with its 96 teeth, will be found very efficient; but the writer strongly advocates the making of a count-wheel from the instructions given in *The Model Engineer.*

For the benefit of those readers whose lathes are not fitted with overhead gear, the author gives at the end of the book a drawing of such an arrangement, which any intelligent lathe user can make for himself at a comparatively small cost.

CHAPTER IV.

Fixing up the Work for Turning and Ornamentation, and the Tools Required.

The chucking, or fixing up, of the work is a matter upon which depends all the success of future operations. Let the work slip or foul, when nearing completion, and the thing is fatal beyond all remedy. Also as much of the work is done without the back centre still greater care is necessary.

Now the very first operation is the roughing out of the work, and the writer suggests—as this is a messy operation—that the whole length of wood to be used from should be chucked up between centres, and the bark turned off its whole length, and that while in this position the various lengths should be marked off with a thin parting tool. This parting tool can be well made of cast steel—a blade made from $\frac{3}{8}$ in. $\times$ $\frac{1}{8}$ in. stuff and fitted into a mount-cutter's knife handle, which can be got from any picture shop for about 6d. Given a little clearance and a keen cutting edge, this tool works well if not penetrated too far. These "cuts" enable the operator to saw up into lengths without any waste, as the cut guides the saw straight. In one end a round hole is bored up, say $\frac{3}{8}$ in. or $\frac{1}{2}$ in., and a plug driven in, which plug has a slight taper. This has also a thread in it which will screw on the spindle nose, or on to the various chucks, and actually

becomes a transfer chuck. See that this plug is driven in truly, if not, waste and lessening of material will result. (See on for further description of use and the making of these plugs).

A very good way to deal with shorter lengths is to file or rasp the wood all over, taking off the bark and knots, etc., and reducing the wood to approximate size. This saves all the mess and grit from the bark from getting into and about the lathe. A very coarse rasp in a firm handle is really the best and quickest tool for such work.

A better way of driving in the plugs than with the mallet as directed, is to place the plug and piece between the jaws of a large vice or cramp, and screw up. In this way the plug goes in straighter. Put copper pieces next the jaws to protect the work and plug. The correction of a plug driven in crookedly is sure to loosen the hold of the same, but the mallet must be used in the absence of a sufficiently large vice. Seccotine placed either in the hole or upon the plug, before being forced or driven in, will give additional hold to the plug. In cold, damp weather use turner's cement.

This is, perhaps, the best place to deal with a small matter upon which most serious issues depend. It is the manner of cutting and ornamenting serviette rings. Being hollow throughout they require somewhat special treatment. It will be dangerous, especially for the beginner, to attempt to cut the whole interior out from end to end if the ring is fairly wide. Take out $\frac{1}{2}$ in. rings from the front end, then smooth and ornament the end and front. Then carefully part off, and

chuck up a piece of box and make a shoulder, say $\frac{1}{2}$ in. wide, and make it to fit the hollow tightly. Drive on gently with mallet and piece of wood covered with velvet, and get it to run truly. Then complete the boring and the other end, and polish before removal with the stiff brush and dry wax, rubbing the wax on the *brush*.

A further method of mounting and cutting out a serviette ring may be included here. Instead of fixing the plug directly into the wood, of which the ring is formed, glue the same to a boxwood face, into which a plug is driven, and the whole trued up. The blackwood or other material can then be trimmed round with a chisel to nearly the size of the circle, and the surface rough-filed flat, and glued under pressure in a fairly true position. No waste will then accrue. When dry, and the whole is mounted upon the taper fitting, the surface can be turned down true. To hollow out the interior, which is very ticklish work, bore a hole right up the middle with a drill, and then remove and mount the whole thing in a powerful chuck, and turn the inside out as elsewhere explained. There is less chance of the work being torn off in this firmer grip. The work can be again put upon the taper fitting, and the work proceeded with, and have the final interior cuts taken, and the exterior then decorated. All serviette rings should have a nicely formed bell-mouth to facilitate their being slipped more easily over the serviette; it also gives them a better appearance.

I am so far satisfied with my "plug" system that I can suggest to my readers the making

of a heavier fitting on the same plan. Instead of a taper fitting, a screwed-on one of heavier design can be made with advantage. Greater rigidity, and less liability to chattering, or shifting work, will result. The same thread can be cut on the outer end for the plugs in general use. In fact, two threads could be arranged for, one for a large plug and one for the usual size.

I have made this fitting in the following manner: A very large nut—that is to say, as regards length —and of the correct size to screw on to the lathe nose, was secured. This was faced off one end and screwed on to exactly fit the thread. Then the outer faces were turned off to a cylinder to within $\frac{1}{4}$in. of the end where the facets were left for the purposes of unscrewing. Into the fore end, bored out to receive a piece of turned steel, 1in. diameter, was sweated the piece to take the thread. This was drilled into through the nut, and pins inserted (three will do) into it and soldered in to keep them from working out. Finally, the thread was cut, and the most useful chuck to take all plugs was secured. This fitting will be seen in the photographic reproduction of the home-made tools (Plate XVIII and Note).

If, when turning rings end for end to finish them, the ring glides on too freely, sufficient bite can be given by placing one or more thicknesses of tissue paper till the grip is obtained. When removing rings after completion, do not twist them off, but, placing the ring between two blocks, drive out the chuck with gentle taps, and no evil will ensue.

In my own case, the nose of my home-made

eccentric chuck (described later), is a $\frac{3}{8}$ in. gas-thread, and the plug is, therefore, made of a gas pipe socket with a thread, the outer edge of which is turned to $\frac{3}{4}$ in. full with the end tapered. Hence this will drive into a piece of box with a $\frac{3}{4}$ in. hole, and hold it for all operations without moving. The screw end of an ordinary twist bit penetrates beyond the cutters for nearly $\frac{1}{2}$ in., and this may cause the hole to come into the bottom of a box being turned. Moreover, it is hard work to make this screw bite, and here is a "wrinkle" to obviate both difficulties. File down the screw of the bit to within $\frac{1}{8}$ in. of the cutters, and previous to boring the hole for plug, run up a small drill of the twist-kind for the distance of the depth of the hole, plus $\frac{1}{8}$ in. more. This will give "bite" for the short piece of blunted screw; it will pass in easier, and also will not go too far into the work. It should be clearly understood that this mention of gas-thread only applies to my own case, or to the case of any one making shift in the same way. When however, anyone makes his eccentric chuck from standard castings, or any chuck bodies, and the nose corresponds to the lathe nose, this *tubing* is of no use. So in all such cases the "plug" must have its internal thread the same as that of the lathe nose, and it will transfer itself to all fittings used with the lathe with perfect accuracy. This is only a question of thread—the plug system is the same in all cases. Every point in economy is studied in this book as well as efficiency. In turning up work to nearly the size, unless the roughing out has been done as above described, the rough piece is bored, and plugged and screwed to a

duplicate piece of tubing fixed in the ordinary s.c. chuck, and when of nearly the correct size is transferred to the eccentric chuck if the work is *eccentric*, or finished on this if the work is *con*centric. It has the advantage, too, of making the work stand away clear of the chuck. The thin ring left after the article is parted off need not be wasted. It can be got off by using the parting tool near the plug without fouling it, and cut through, the little piece left being broken off afterwards.

These rings can be let into other pieces, or can be left wide enough for serviette rings, and finished right off in this way. The writer would suggest the making of several of these plugs as they will be found of great use where a piece has to be left in while another is turned. Fig. 1B, Plate VI, gives a true idea of the plug here described. This seems to require a further word of explanation. This is what is meant. If a number, say 6 or 12 or even more, of these gas plugs—gas thread sockets—are purchased at a cost of 1d. each, and turned as Fig. 1B, VI, they can be attached each one to a *boxwood* plug, *and they two then become one*, and are used to mount each piece of work, and, as elsewhere stated, enable the work to stand further away from the fittings—provided, of course, the *overhang* is not too great to cause chatter, when the *back* centre cannot be used. The worker will find in inlaying work that quite a number of these are required and too many can hardly be made. Fortunately they are cheap.

The mounting of work of so thin a diameter as to disallow of the insertion of the usual plug, may be

accomplished in the reverse way, viz., driven into the hole in the plug. The front threads can be removed, or the worked screwed in instead of driven, but the former is the easier and the more secure. The ordinary wood screw chuck I do not recommend, as it either splits the wood or tears away the thread. It is all well and good for soft wood turning. Hard woods do not take to it so readily. The above directions in chucking the work will be found to be the best possible instructions that can be given after much experimenting and many trials.

Tools for Use in Turning-up Work for Ornamentation.—Fig. 2, Plate VII, gives the best kind of tool for working up from the rough. It is called "The Conqueror," and is sold by Adams for 4s. 6d. Silver steel cutters, $\frac{3}{16}$ in., can be speedily made by filing up and hardening. Fig. 2, Plate VI, gives the best point for taking the first cuts, leaving the work clean. Fig. 3, is the tool exchanged for the first to take the merest shaving off and leave a polished surface. Let this be very keen. Let it be observed, too, that when cutting across the end the best plan is to set in the tool at centre and work outwards, the reason being that there is less possibility of "hitching in" the tool and tearing the work off its plug. But only carelessness can do this, as these plugs hold most firmly, and no ordinary thing will move the work on them. It will be observed that *here* but few tools are mentioned. Those for roughing-out either by hand or in the slide *are few*—a gouge and a flat chisel for hand work, and the above mentioned tools for the rest. But the mention of another tool which

was made from a swan-necked tool will not be out of place. It was merely ground off to a cutting-edge, and the style and shape and manner of use will be fully understood from the view of it given amongst the other cutters in the photograph in one of the plates. This tool will take heavy and clean cuts if fed up as the work will allow. In making box lids, the proper way is to make the end true and clean, and then hollow out and part off. Next turn the shoulder on the box part and cut out the inside and reverse the lid, but let it fit the shoulder very tightly, for this is to hold the work while being faced up and ornamented. It cannot be removed, but leave it and the box on the plug for, say a day or so, when it will be found loose enough to be pulled off comfortably. If made an ordinary fit at the first, the lid, even with seasoned wood, will be loose on the finished box. And the plugs in hand will enable other work to proceed while waiting for this to take place. For the hollowing out, the following is the best method. Bore up a hole, say $\frac{1}{2}$ in., with a drill, truly central, then with a parting tool cut up to the same depth as the drill has penetrated near the edge, and thirdly, with a hooked parting tool inserted up the central hole, meet the two cuts and a ring will fall out, a ring that can be used afterwards, and this will also effect the saving of much in the way of shavings and dust.

Before dismissing this subject, I should like to add in respect of the hollowing out of a box interior that the central hole through which the right-angled parting tool is passed up, must be quite true. To secure this, and not to rely on the twist drill running up

quite straight from its start, a smaller hole can be drilled and afterwards trued with the following tool, Fig. 4, Plate VI, as described already in *The Model Engineer*. But let it be noted that if, say $\frac{3}{8}$ in. hole is bored for $\frac{3}{8}$ in. up, and then trued with this said tool to $\frac{1}{2}$ in. to exactly take a $\frac{1}{2}$ in. drill beyond its cutting point so that it fits the hole truly, the drill will go on in a perfectly straight line for any distance. The reason for the necessity of a true hole is this—it allows the tool to cut without jerking, which would not be the case if the hole were eccentric. Jerking is to be distinctly avoided in all cases of ornamental turning.

For certain work, as that of cutting material revolving upon the eccentric chuck with a fixed tool, the slide-rest is used to hold the tool and to regulate its movements. But a holder is necessary into which to place the tools. For economy's sake nothing can be better than the use of two or three holders of square material bored to take certain sizes of round steel, say $\frac{3}{16}$ in., $\frac{5}{16}$ in., and $\frac{1}{2}$ in., and reducing the cutting edges in every case to the required width, by filing, to decimals of an inch. A set-screw in the side will be necessary to hold the tool firm. Hence all sizes from $\frac{1}{2}$ in. width of cutting edge down to a point can be got. A flower pot, lined with fire-clay fixed on an iron tripod, and blown by an ordinary bellows, is a capital thing to use for heating and tempering these small tools, using broken coke as fuel.

Plate X, gives the varieties of drills, and the patterns of the cutting ends, to which can be added as many more as the amateur can design himself.

In Mr. Evans' work certain kinds of ornamentation are detailed which deal with bored cylinders to remain either hollow when finished or plugged with wood of another colour. But as in nearly all cases ivory is the material bored, the plug used to cut into, to prevent breakage when the cut goes through, is usually glued in and afterwards loosened by being plunged into water. But if water does not hurt ivory it would spoil wood and therefore another expedient must be adopted. The writer acts in this way: He glues the plug only at each end, allowing it to be longer by that much each way to allow of the glued pieces being *cut off* when all is completed. Then the plug will slide out, especially if it is not made too tight a fit. Care is needed in this operation.

It should be remembered that one expedient is always to hand where the turner can wait, that is, he can glue his piece of wood or material to a wooden face-plate, let it dry, and then proceed. In this way no chucking marks appear and the wood can be used right up to the face-plate.

The universal cutter.—This tool bears this title on account of its being both the vertical and horizontal cutters combined in one frame, with powers also of adjustment for any angle of inclination between these positions. Two kinds of frame-work are possible, but one, the design of J. H. Evans, of London, is superior to the other for certain kinds of work, where awkward corners have to be negotiated, but is very much more difficult to make. Both these tools are described, and will be understood from Fig. 3, Plate VII, and Fig. 1, Plate III.

Now the simpler will be explained first. To make this I have hit upon the idea of improvement in the matter of manufacture, for instead of suggesting the cutting of the main frame from solid stuff, or getting a casting made from a pattern, or getting the local smithy to make up a clumsy frame that requires no end of machining, I suggest the following procedure. Use mild drawn steel bars of square section, the size used being determined in the following way: Find the exact distance between the top of the tool rest on the top-slide and the height of centres. Double this and get a bar of steel of the requisite size, as in the case of the drill-spindle. In this case the tool will always be at dead centre. But any size may be used if "packing" is resorted to. Having procured the steel, cut off the lengths required. Put these into the four-jaw chuck and centre truly. As this steel is usually very true a scriber set to the corners will give the truth required, or a tool held in the tool-box with a point will do as well. Place white paper on the bed, as this aids the eye. Thus fixed, the steel bar pieces can each be faced on the ends and rendered true right angles to the faces, ensuring the frame being rectangular when put together. Next take the three pieces forming the fork ⊔ and fix in the following way. Make the parts bearing contact quite clean and bright with fine emery cloth, for these are sweated together. On a metal surface, say a piece of faced-up cast iron plate, lay the long piece and place vertically on one end of it a short arm, having previously faced the contact parts with solder. "Tinol" solder paste is excellent

for this purpose. With a blow lamp now sweat the vertical piece to the horizontal, and, while in the moveable state, set the square all round so that the two are square and true in every way. Then let them cool. The blow-lamp can be got to the work and round it better if the end piece overhangs the metal plate by just the distance of the piece being sweated on. The other end is treated likewise. Perhaps some engineer will quarrel with me, and say this is not legitimate engineering. But my reply is, the amateur will make a better job this way than by trying to forge the thing to shape in the solid, or working up a casting. Now further to strengthen the frame, when the whole is set, drill a hole up the short arm through the end of the long piece forming the base of the frame at each end, and tap and fix a screw with a flat head and fit tightly. This will make a good job of it. Now either at this stage, or previously, which ever is most convenient to the worker, drill and tap the holes for the centres to take the revolving spindle which carries the cutter. It will be perhaps a truer way for the amateur to drill the holes before fixing the uprights to their horizontal bar by sweating them together truly and drilling both together, and then unsweating them and tapping them for the screws afterwards, and fixing them in their final position as directed.

The centres can now be made to an angle of 60°, and the screw long enough to allow lateral adjustment, especially necessary when an under size of material is used for the frame, thus allowing the tool to be either below or above the

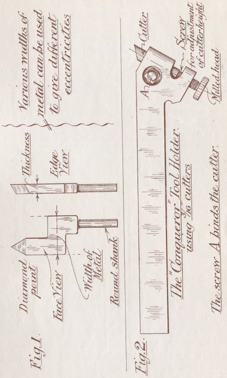


PLATE VII.
Fig. 1. Cranked Diamond Cutter. Fig. 2. The "Conqueror" Tool Holder.
Fig. 3. (See next page.)

(Facing page 40.)

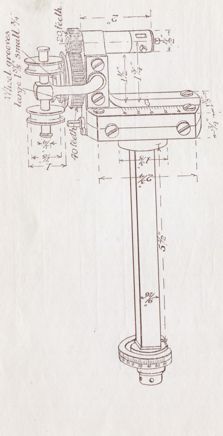


PLATE VII.

Fig. 3. Drawing of the Evans Universal Cutter Frame (see Chapter IV).

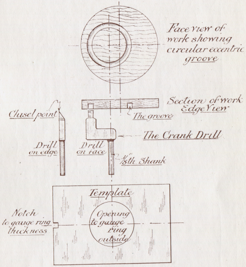
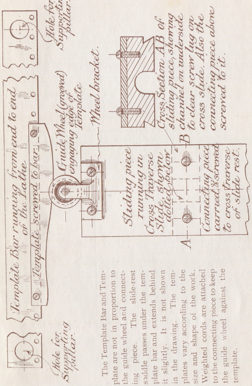


PLATE VIII.

Showing one Method of Cutting for Inlays (see Chapter VII.).



The Template Bar and Template are not in proportion to the guide wheel and connecting piece. The slide-rest saddle passes under the template bar and extends behind it slightly. It is not shown in the drawing. The templates vary according to the size and shape of the work. Weighted cords are attached to the connecting piece to keep the guide wheel against the template.

PLATE IX.
Apparatus for Curvilinear Work (not to scale).

centres; it avoids packing up, etc. Provide a lock nut for each. Now comes in the question, shall the spindle be driven direct by a pulley wheel on it, or by two geared bevel wheels? If these latter are used they obviate the necessity of using guide pulleys when the frame is used in the vertical position for horizontal cutting. The writer prefers to do this, as it is more satisfactory, and very little extra trouble, especially as bevel wheels can be cheaply purchased ready for use from such firms as The Liverpool Castings Co., or Whitney's, in City Road, and fitted on. The frame in this case will require an additional piece on one side as seen in Fig. 1, Plate III, to provide bearing for the second spindle carrying the pulley. All the rest will be clear. The now remaining work is that of providing the shank. This, of a length sufficient to overhang the tool-rest both ways, is bored or drilled through, and a spindle turned to fit snugly in it. This spindle is also passed through the frame and secured with a nut. Another way, instead of boring—a long and tedious job—is to turn the shank down to a circular section at one end, fit it truly in a hole in the frame, and then make a thread in the projecting part by which to tighten it. If it is necessary to know the angle at which the tool is set, and to correct the vertical and horizontal positions, a semi-circular plate, graduated, must be fixed to the frame, and a "zero" marked on the shank. Interchangeable spindles can be made for use with flat or square or round cutters, also one extra for a circular saw, or small emery wheel, etc.

If the guide pulleys are preferred to the other method, then the arrangement will be a projecting bar carrying a cross piece on which two loose pulleys will run to conduct the band from the overhead to the driving pulley. (See *The Model Engineer*, June 18th, 1908.)

The description will now be given of the second, and improved kind of tool (Fig. 3, Plate VII), one that will work in any corner, etc., because it has no projecting parts to foul the work, and being geared, has also additional power for driving the cutter. Cutters, too, of smaller radius can be used, making special kinds of work come within the range of this tool as with no other. As Mr. Evans describes it, it is by no means an easy task to make it. But the following modifications will make it easier. Angular faces and grooves are not easy to fit to a nicety, and it is upon these that the precision of the tool depends. Again the engineer will quarrel with me, but the end will justifiy the means in this case also. Instead of making these angular fittings let the amateur try his hand at round ones, a job he should be able to manage. Now in this case it is necessary to have the arm carrying the cutter and wheels fixed to a slide working in grooves as seen in Fig. 3, Plate VII. Let it be assumed that the writer has made the shank, and fitted a spindle to it, on the one end of which is a $1\frac{3}{4}$ in. collar and a plate fitted to this collar to carry the guides, and on the other end the graduated semi-circular disc and binding nut, and that he is now ready to affix the guides and sliding frame. Proceed as follows: Cut a length of steel bar, say for

example's sake $\frac{1}{2}$ in. × $\frac{1}{4}$ in. Along one side a semi-circular groove is required which can be got in two ways. The first is to sweat the two strips edge to edge, and to securely rivet to either side a flat piece covering the centre join. Place three rivets on each side, and see that it is quite firm. Drill next a $\frac{1}{4}$ in. hole down between the plates quite centrally, and when unrivetted a groove, correct and true, will be found along each edge. The holes through which the rivets were can be elongated towards the ungrooved edge on one piece for the fixing screws. Now take a piece of flat steel $\frac{3}{8}$ in. × $\frac{3}{16}$ in. and cut two lengths longer by $\frac{1}{4}$ in. than required finished, and sweat them together. They will form a $\frac{3}{8}$ in. square. Face off the ends and centre very truly, nearly true will not do. Upon this depends the success of the working. When truly centred, place between centres and turn down to an exact $\frac{1}{4}$ in. round, the spare $\frac{1}{2}$ in. will accommodate the carrier. Now remove, cut off the odd piece, and unsweat. Two pieces, semi-circular in section will result. Through these, placing the flat sides next the poppet-head spindle with the centre removed, drill three holes $\frac{1}{8}$ in., using a drill of the tapping size. One of these is then placed on each side of the sliding-plate and screwed to it. Place each in position, and, using the same drill, make the holes into the sliding plate. Tap them and then make clearance holes in the semi-circular pieces and screw with countersunk screws in their places. If now the strips previously grooved are placed in their positions, capable of adjustment by the slots, and the sliding-plate put between them, a very smooth and

equable movement will result. By my method of first of all sweating parts together and then securing by screws, I can get awkwardly shaped pieces made up. Hence the rectangular arm carrying the guide-pulleys and spindle can be sweated to the sliding-plate and screwed up. The sweating holds the work in position while the drilling proceeds. It is better than clamping up, and has the extra advantage of keeping the course clear of clamps which are often in the way. No further description will be necessary —the drawing makes all clear—than just this, that the wheels are geared as two to one, a 40 and a 20 wheel, and these and the spindle run on hardened cone collars made to an angle of 30°. Old disused bicycle bracket spindles from good machines are the best material to get, as they anneal beautifully, cut clean, and harden again to perfection.

The second method of grooving the guide strips is to grind them out with a wheel or to mill them with a milling cutter. The first method, however, will be the better for the ordinary amateur, and will be done with the ordinary tools to hand.

Cutters for ornamental turning (see Plate X).— Cutters of various shapes and sections are used in conjunction with, and carried by, the drilling spindle, the slide-rest, and the universal frame for the various purposes of ornamentation. Tools in the slide-rest are of necessity stationary ones from the rotary standpoint, but all the others are revolved at high speed, the frame itself being stationary except for the movement it receives from the slide-rest upon which it is fixed. Now the following details will consist of an attempt

to show the reader what great variety attaches to the methods of procedure, and the range of patterns produced by these methods.

Departure will also be made from many regular methods, both of making, sharpening and using the tools. As one example it may be said that the usual text books describe certain tools as being incapable of lateral movement, which movement would destroy the pattern they cut; but it can be shown that by a limited movement, with the tool revolving in the usual direction, quite a new pattern is evolved, distinct in every way from the ordinary pattern of the tool. In the following pages this will be explained and examples given in the plates.

Firstly, let us deal with tools cut from circular metal requiring to be filed down to the half section for cutters. All such cutters as are made in this way must be very exact as to shape if they are to cut properly. The following method will ensure this. A circular piece of metal is placed in either the taper hole of the headstock (having been previously tapered to fit)* or the hole in the drilling-spindle in the same way. In each case the cutter must be turned in the position in which it is to be used when finished.

A piece of steel is supposed to be fitted, tapered, into the headstock centre hole—in place of centre— and against it the tool-rest fixed for use with the hand-graver—a tool most useful to any turner, consisting of a piece of square stuff fitted into a handle and just cut off diagonally at the front end and hardened.

* Of course only large cutters fit in this way in headstock. If a small tool is required, make a mild steel fitting to hold same to save material.

There are then two cutting edges and a point. A three-cornered file can also be ground off for the same purpose at an angle of about 45°. With the "graver," using the point, turn a minute dot in the centre. Across this centre exactly, "scribe" a line, and file to this. (See on for directions on tools for use in milling out V slides). To get the lines for filing away an exact quantity from a given point beyond the centre to the edge, with the "point" of the graver make a fine circle, the width of it being equal to the width of the piece that is to remain. Say a flat central piece is to be left for two cutting edges, the thickness of the piece to be $\frac{1}{8}$ in., then make a $\frac{1}{8}$ in. circle. File to this and turn the material round to the other side, and file to the circle again. This gives truer results than by trying to scribe two straight lines about the centre. The diagram, Fig. 2, Plate IIA, gives the idea.

Now the ornamental turner will find a very useful set of tools, costing 1s. 6d. inclusive of handle, made by Stanley & Co., consisting of the six blades with a cutter at each end used for beading by hand. Held close to revolving work, in either wood or soft metal, these cutters will produce mouldings fine and clean, and all precisely alike, with a minimum of trouble. The handle made for them is of no use here, but is for use when working on straight pieces by hand. The cutters, however, can be held either in the fingers or in a handle made for them. Cutters can also be filed out, of any desired pattern, from flat cast steel.

As nearly all tools used in ornamental work are made to some decimal part of an inch, it is advisable that

the turner should use a scale divided into tenths, and from this produce some gauges and mark them. These will be used as templates in gauging the tools being made, so that they may be exactly alike and not approximate. Flat, mild steel, case-hardened after being cut out, is an admirable material for these gauges. Old hacksaws also answer the same purpose.

When the cutters are made they must be not only keenly sharpened, but finely polished, in order to leave as clean and polished a cut as the material being treated will permit. No tool can be too keen whatever the material. Expensive tools for sharpening, such as the "Goneostat," are used by ivory turners, but we may possibly not have the use of these and must resort to other means, and Mr. Goldsworthy-Crump's little appliance (*The Model Engineer*, of June 18th, 1908) gives the way to do it; but by this means, only what may be called plain tools consisting of straight lines, or curves, can be sharpened with it. For tools consisting of many facets, some straight, others circular, etc., and very fine too, a special care is needed in these operations. The writer has conceived the idea of cast iron discs, with several steps upon their circumferences, as being good for this purpose. Against these the minute tools can be held with care. The revolutions of these being in the opposite direction, that is from the operator, it would be better to use these discs upon arbors set into the frame described in *The Model Engineer*, of June 18th, 1908, and running upon centres, and driven from overhead. This little frame can carry the whole of the apparatus for grinding and polishing

if each thing is provided with a spindle. Old hones, of good quality, can be cut up into small wheels and mounted in this way, the odd pieces cut off being broken and ground up for grinding powders, kept in boxes free from dirt and grit.

While speaking of grinding and polishing wheels, etc., it may be as well to give a wrinkle as to the best method of mounting the same to a spindle. Preferably to making a thread and screwing up the various wheels against washers and nuts, I use the following method, the same process as that used for fixing work on a mandrel to turn it, viz., that of making the spindle very slightly taper, driving the spindle then into the hole, and on the other side, driving up close to it a sliding collar, which adds to the binding and makes a firm job. As there is no great resistance these will remain firm, and will run truer than when washers are used, and are less trouble to begin with as regards the manufacture. Metal wheels can be driven on with a fair amount of force, but it would be wrong to suppose an emery or other composite wheel will stand it. Therefore, go with care and use a little cement, and true up the wheel before the cement gets hard. Wheels that are made from old stones can be chipped to nearly the size, then bored for spindle, mounted firmly, and then "turned" by means of old pieces of stone harder than the one being cut. But be careful of the dust. Cover the lathe and all parts into which this fine grit could penetrate, and then afterwards well clean everything. Save all powder that is clean and fine, and mark the "grade" on the box.

Emery sticks, costing 1d. each, can be got from Adams', and are very useful, in the finest grades, for polishing the tools for use. Of course, the use of the fine cocus powder gives a better finish. This is 2d. per box.

A special grinding jig made by the writer and shewn in Plate XVIII, is here described in the few words necessary to make all things quite clear. The frame fits into socket of hand-rest and can be fixed to tail-end of lathe bed away from all other parts of lathe. One centre is fixed, the other withdraws, and is secured by means of a screw, as seen in photo. A stage is placed in front, between two plates, through which two holes are made, as bearings for the rod which supports the stage, and upon which it revolves. A screw at each end secures it in position and also tightens the same when grinding, etc. This stage carries the tools being ground, and small angular fittings made of angle iron or brass are made to slide along its edge and keep the tools in their correct positions while being sharpened.

The wheels are made of wood—box or other hard wood—and are coated with emery and glue. They are made to exact pattern of the tool and made with the tool itself before the emery is applied. Box discs can be sawn off in quantities, and kept to hand all bored ready for immediate use. So if a certain pattern tool is made, take a disc of its width, mount it on this spindle and turn it, as on a miniature lathe, in its own position. Cut up these disc in tenths of an inch and have a stock of each size used. Polishing wheels can also be made in the same way.

A half circle in brass is graduated in degrees—shewn to left of photo—which works against a pointer, thus giving the degrees at which the tools are presented in the *vertical* direction. A small fitting could be made for twist drills, also with the usual horizontal and vertical degrees fixed, viz. 59 and 79 degrees.

CHAPTER V.

THE ECCENTRIC CHUCK: HOW TO MAKE AND USE IT.

So much can be done with, and so much must compulsorily be left undone without, an eccentric chuck that it is to be looked upon as a matter of necessity in the ordinary "kit" of the ornamental turner. But, oh! the price of such an article! The price lists frighten us, but really there is so much work in them that one is not surprised. Let us, however, be ambitious and make one. If we like we can make patterns and get castings in, preferably, gun metal or cast iron. But the author has made his from scrap entirely.

A small face-plate was screwed to the lathe nose and the chuck made on it. The following description will enable anyone to make the same from either castings or scrap. The writer has been sorely vexed with the inadequate descriptions given in books on ornamental turning, as to the making of *apparatus*, etc., such descriptions being entirely misleading in some cases, and these will be referred to.

Perhaps it may be of service to first of all detail the purposes to which this chuck is put, although careful perusal of the drawings (Plate IIA) will make all clear. But these remarks apply rather the use than the manufacture of it (see also Plate II.)

The eccentric chuck is screwed in position upon the lathe nose like all others, but is equipped with such movements as enable us to throw its centre out of concentricity with the lathe nose, and to create new centres anywhere we wish within the capacity of the tool itself. To effect this the chuck is constructed thus: A plain plate, with two parallel sides, carries upon it two guide strips between which there slides, with perfect fit, another plate carrying a wheel which revolves upon it, which wheel in its turn can be either fixed or revolved as the work demands. By such means, circles, having their centres eccentric to the common lathe centres, can be cut with ease and certainty. Face patterns, or cylindrical patterns, can be cut at will. To cut the former, face up the work true upon its face first of all. Any rough or heavy cutting had better be done previously upon a chuck of ordinary kind, as any strain on the eccentric must be detrimental. The final cut can be taken when the work is fixed in position. The eccentric nose, which becomes a second lathe nose, must be placed quite concentrically, and the centring pin placed in position, and then the work faced off. This done, and the pin removed, the screw is given enough turns to produce the amount of eccentricity required, and the screw being ten threads to the inch, enables the exact amount to be known without measurement. It is well to fix a bar from the head-stock end to a firm object, as the wall, etc., as the chuck sets up a great deal of vibration, which this precaution prevents. A few experiments will now enable the turner to set the eccentricity of chuck and the position of tool in

slide-rest correctly. It is difficult to explain in a book. The Plates and examples will enable the powers of this tool to be grasped in principle. Cylinders can be decorated with an infinitude of designs by first cutting a true cylinder, and then setting out the eccentricity, taking the first cut, revolving the wheel a given number of turns after each cut and before taking the next, moving the tool in slide-rest exactly its own width. Eccentric circles will result in a spiral twist around the common centre and the back centre must be used each time to hold the work true while being cut. The width and pattern of tool will determine the final appearance of the column. Wide faces on such work could receive further ornamentation by studding or drilling, etc., as in other places described in this work. Figs. 54 to 56 in Mr. Goldsworthy-Crump's articles, June 16th, 1910, will give one of these executed, the only difference being that done on the eccentric chuck, the work is more expeditiously effected than by marking out the centres as he suggests. A trial will prove this.

Now to proceed with the making of the eccentric chuck. In the first case, if scrap is used, get cast iron from an old grate or other article broken up, and cut out the pieces for the back plate, front plate and strips, say $\frac{1}{4}$ in. thick. The sizes must depend on the lathe for which it is made. For mine, a $3\frac{1}{8}$ in. Milnes', the sizes are back plate $3\frac{3}{4}$ in. $\times$ $2\frac{3}{4}$ in., front plate $3\frac{5}{8}$ in. $\times$ $2\frac{1}{4}$ in., strips 3 in. $\times$ $\frac{1}{4}$ in. $\times$ $\frac{1}{2}$ in. All these are placed in a 4-jaw chuck and faced up true. The back plate is then fixed with countersunk screws to the face plate and again faced

over and trued up with a light cut. An $\frac{1}{8}$ in. hole is drilled in the centre for the centreing pin.

The Rev. James Lukin in his nice little work on "Simple Ornamental Turning," says, in respect of cutting the V-grooves in the front plate, that these can be cut by placing a tool in the chuck and the work on the tool-plate of the slide-rest. This can be done, but his description of how to make the tool is peculiar. He says it must be "a flat-ended tool," and that is all. Here is a description of the tool and the manner of use. Of $\frac{3}{8}$ in. cast steel place a length, say 2 in., in the chuck, and with the hand-graver cut off the outer skin and face off the end. With point of tool mark the centre with a dot. Punch a dot also against jaw I of the chuck, so as so replace exactly. Next turn down the end to 60°. If you have a graduated slide you can use the slide-rest for this job, but if not, make a template by using a three-cornered file, and nicking a metal plate with it sufficiently deep to serve as a template, and turn the end of steel to fit it. Now remove and file down to the half, and back off from the top cutting edge right round to the under edge, the top edge being the one that is uppermost when the flat face is towards you in the chuck. This top edge is called the cutting edge. Tool revolves in screw-cutting chuck towards you. Flatten the extreme end a little and again back it off, this will make it cut better and cleaner. Harden the tool and it is ready for use. Assuming that the front plate is trued up, the sides parallel, and the ends rounded, and the centre line scribed all round, set it up on the tool plate and see if it is low enough to get

it down to centres. In my case it was impossible, but I got over the difficulty by placing the angle plate on the verticle slide very firmly, and setting the whole up truly, vertically and horizontally, and true also with the cross-slide to traverse in a right line across. I then laid the plate on the angle plate, and fixed a "dog" in the ⊥ slot above and tightened down on it with packing, then worked down to centres, fixed the tool, and proceeded. I had previously taken out much of the material with a file to lessen the work and strain on the tool. When the slot is finished to depth and width required, reverse the plate, keeping the same side up, and do the same for the other side. The groove will be flat-bottomed. This does not matter, so long as the apex is removed from the strips which slide in the grooves in order to clear.

Now with scriber and surface plate—plate-glass will do—scribe a line all round the strips about half-way up. This line will shew where the V faces begin. From this halfway line they taper off to the top edge. The angle plate must be set horizontally. Scribe a line also all round the angle plate, near the edge, and to this line the strips can be set truly. Use the second strip behind the bolt as a packing and bolt down fairly tightly, then with hammer adjust the strip to the line and finally tighten. By using a small mirror the under line can be seen as if on top by putting it under the back end. In my case I had to let the back end overhang to bring the front end past the tool in feeding across. This would be the case nearly always with others. Hence the use of the glass. When the tool is set do not alter it, or the

work, as both slides must be alike. Simply draw the cross feed towards you and reverse the work, and again fix to the line and all will be correct. In the case of the strips much material can be removed from the V's with the file before fixing on the lathe. The *thickness* can be turned off while held in the 4-jaw chuck. This remark refers to the removal of material for the Λ's. Do not remove too much, however. A better tool for V-ing the strips only, one having two cutting edges, is made by taking another piece of steel, and instead of turning it taper, file off an equal lot each side of centre dot, leaving it $\frac{1}{8}$ in. thick. Then file away to the template, getting the Λ upright with the tool, and then backing off from each cutting edge. This tool revolves like the other in the screw-cutting chuck. Work fed across. This cuts cleaner and quicker, but will not do for the grooves in front plate. Now, if all is correctly done, the strips will run in grooves truly, after the apex of each is filed off to just clear the bottom of groove and the surfaces smoothed with a fine file. All this may sound dreadful, but it is really interesting work.

Mr. Lukin again leaves us in the dark as to how to fit the screw to actuate the slide. I shall describe how I fitted mine. The screw can be either a square or round thread, 10 threads per inch. A good V thread is better than a bad square one, and the "nut" is an easier job. A groove was drilled out $\frac{1}{2}$ in. wide across the centre of the back plate for the nut to work in sufficiently deep to allow the thread to just clear the back plate in working. This slot can be of such length as to give the amount of eccentricity required

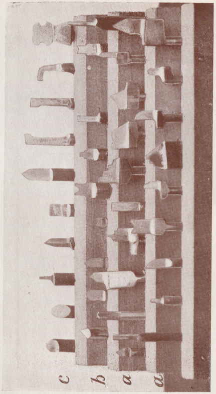


PLATE X.
Cutters for Ornamental Work (see Notes in Appendix).

(*Facing page 56*)

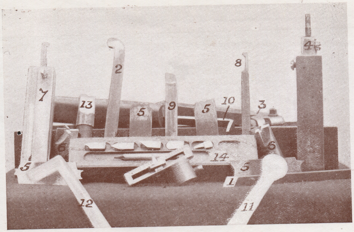


PLATE Xa.
Slide Rest and other Tools (see Notes in Appendix).

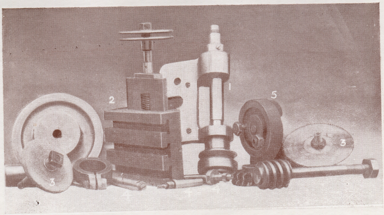


PLATE XI.
(1) Large Drill Spindle. (2) Vertical Slide. (3) Emery Wheel and Circular Saw. (4) Taper Fittings. (5) Fitting for Using Slide in a Horizontal Position.

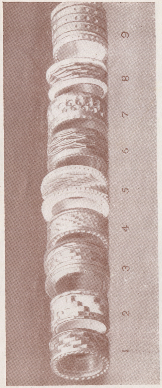


PLATE XII.
Examples of Serviette Rings.

in the slide. The nut of $\frac{1}{2}$ in. round steel, instead of lying horizontally, is a vertical one, and passes right through the front plate and lies flush with its upper surface. The thread then runs through it across its section, not its length. Before the screw can be fitted, the front plate must be bored with a $\frac{1}{8}$ in. hole in centre, and a rod passed through it, and the back plate and the strips fixed in the usual way, viz., by the front strip being screwed to the back plate adjusted to the front plate on its pin, the pin removed and the other strip fixed, making the screw holes elongated in order to adjust for fitting and wear. All this will be clear from the drawings. When the slide is in working position, the hole for the nut, and the length of the under groove, can be determined with ease. Some of my readers, though ignorant of ornamental turning, will be, nevertheless, clever turners in metal, and to them I would say, make the dividing wheel to work by worm and tangent, but for the less experienced it is a case of hands off. A click and detent will do equally well. The teeth can be milled, 96 in number, and a secure click fixed, and all will be well. The method of fixing this is described later on. Thus made the eccentricity all works one way. Therefore fix the head of screw on the opposite side to that from which the slide works outwards, else the screw-head would be under the slide, a not very comfortable position. I must here add that the front plate, too, is grooved to allow the screw working room. If, however, the worker prefers, he can drill this by fixing the front and back plates in position firmly, and drilling to the depth required, instead of milling separately.

The chuck being now so far together, the final stages of fixing the toothed wheel carrying the duplicate mandrel nose, or a nose whereon to fix the work, must be attended to. In my own case, an old brass mount, ¼ in. thick, was taken from a large tripod stand and made to serve. This was of larger diameter than usual, but it was kept so and just trued up, and the teeth cut as follows:—The wheel had two bosses carrying a ⅜ in. gas thread (see back on ⅜ in. gas threads), and by one of these it was mounted in a S.C. chuck, the edge trued and then the teeth cut with a circular cutter fixed to the drill spindle upon the vertical slide. By means of the lead screw this revolving cutter was passed clean across the edge each time, which made each groove between the teeth quite flat, and of the same depth. This done, 96 teeth in all, the back of plate was recessed to fit over a ring, screwed upon the front slide covering the hole through which the nut was passed to keep it in place. Then a hole, ¼ in., was drilled through the centre, and a pin trued up having a head made to fit a hole bored to receive it in the under side of the front plate, the ⅛ in. hole already bored in front plate being enlarged to same size, and recessed underneath to take head of this screw. Passed through from the under side, and through the hole in the wheel (the back boss having been now cut off as no longer required), the pin was secured by a nut let into the end of the front boss, or nose, and a very short grub-screw screwed in to act us a lock screw. Hence the wheel could turn, stiffly and smoothly, carrying with it the pin, the wheel itself being kept central by

its underside groove working upon the ring fixed to the centre of the front plate.

It now remains to be said that as my own wheel was thus adapted and had already a screwed nose of standard gas thread, it was only necessary to get as a plug a socket piece of iron and turn it true while screwed in its place. So the chuck was mounted upon the lathe, and this done, and at the same setting tapering the outside very slightly.

Now if the reader will turn back and follow the description of the manner of mounting work up, and using these plugs, all will be clear. The little click arrangement is merely an upright with a hole bored carrying the click. The click itself is soldered to the screw passing through the clearance hole, so that the nut when loosened releases it, and when tightened again fixes it. No spring is needed. This long description has been necessary as dealing with "makeshifts," on the assumption that many amateurs will be doing this when making their own. A careful study of the photograph of chuck will enable any intelligent man to grasp the whole clearly. The writer has marked with dots, numbering tools being absent, the front of wheel near teeth—two dots at every fourth tooth, and three dots at every quarter-division, to enable the operator to calculate more easily and expeditiously.

A final "precaution" is perhaps necessary. In making the above chuck out of "scrap" materials, which necessitates so many screws being used, see that no screw is placed in such position as to be in the way of any grooving, etc., in the process of making.

Since all the above was written I have added a centreing screw to the chuck to give it greater strength. The strain of even light turning is rather heavy on the click—all the strain in a circular direction falls to its lot—hence the idea of a screw. Anywhere on the front of face, so that nothing else is "fouled," a hole can be bored and tapped into the front plate, and when the work is being shaped, or any concentric work being done, this screw can be in position. It is removed when the slide is drawn out for eccentric work. This hint may save trouble ahead. I use this in place of the centreing *pin*.

The dome chuck.—This chuck scarcely comes within the domain of this book, it being used, as a rule, for advanced work. It consists of a lathe nose duplicate fixed to a "click-wheel" as in the eccentric chuck, and is placed vertically so that the work stands in an upright position. The nose and click-wheel can then be drawn up or down by a screw working in a vertical slide and the work with it. Hence, such things as domes and other similarly shaped pieces can be operated upon. But although this article will not describe the manufacture, it will contain a suggestion for an improved arrangement to enable some work to be done similar to that done on the "dome" chuck. If the reader has a vertical slide so much the better. Fix the large face plate on and take out the gap piece. To the face-plate fix the angle plate. To this affix, in an upright position, the vertical slide. Get it "straight" across the bed of lathe. To the front of this, in the slots in the face, fix another angle-plate consisting of an iron plate with a short limb and a long one. Get a smith to make it and then true it up on the two outer faces.

Fix the short one to the vertical-slide and let the other project horizontally, and in a level plane. To this surface now fix the wheel of the eccentric chuck, already made, in just the same way as the same is fixed to its own chuck. Therefore bore a hole through the plate for the pin and fix a ring on the top for the wheel, and you have the improvised arrangement, which will enable you to do a good deal of useful work with ease. This may seem, and really is, a cumbersome and heavy tool, but as it has not to perform rotary movement except by hand, and is stationary during cutting operations, this does not matter provided, of course, that the whole is rigidly screwed together. Any position from the vertical can be got by using the segment engine, if one is on the lathe, or locking by means of the back-gears, as the arrangement must be held firm during operations and not allowed to hang free. Vertical movement is got by the vertical slide.

Certain kinds of dome work can be done by the eccentric cutter placed at an angle of 45°. This is explained under the heading "Designs."

CHAPTER VI.

Designs:—Their Manner of Execution, and Suggestions for the Making of other Designs.

Plate No. V is arranged and presented for the purpose of giving a few ideas as to the capabilities of the various instruments described. It should be understood, however, that these few patterns only give the "principle" of the thing, as it is not possible to say that any limit exists as to the variety of design that can be got with even the simplest tools. It is the desire of the writer that the readers should develop the ideas concerning the reverse action of certain cutters which "only cut one way," as the text books declare. I have got some lovely designs in this way, effects not to be got in any other manner.

Let Figs. 1 and 2 be a sample of the capabilities of one cutter alone worked the correct way, then traversed with various movements of the work and mandrel to correspond. These experiments show more than any words the meaning of this departure from ordinary practice.

Infinite variety will result from various experiments with these cutters, penetrated to different depths and moved different degrees, using the segment engine and stops, and count wheel.

Fig. 3 gives the idea of a metal inlay. As the inlay

is described already on a previous page it is not detailed here. But the surrounding boxwood, which is really a lid for a box, has a circle of 12 intersecting eccentric circles cut with a diamond tool, in the holder described for the slide rest to hold $\frac{3}{16}$ in. circular steel. These hardly show in the photo, being so fine, but the same pattern is shown on another lid, Fig. 4, giving the effect better. The inner design is of six circles interlacing eccentrically. These designs are really much more beautiful than they can be made to appear either by photo or print.

The design is the result of first cutting the outer ring with the face of material quite concentric. Then give the required turns to the screw, and set the tool and see that it is correct before making the first cut, missing the outer ring and clearing the centre, then make the first eccentric cut with the click in 96 tooth. Move to the eighth tooth, cut again, and so on to every eighth tooth. By cutting eight and four alternately, a nice change is to be got.

Fig. 5 is a specimen of the various patterns cut with a step drill, running in the drill spindle and moved along, thus cutting stepped grooves. The dark parts show where the drill, getting hot, began to char the wood, a very easy thing to do with light woods. This can be avoided by working and withdrawing, so as not to get the drill so hot, and by having plenty of clearance behind the cutting edge. The dark effect, however, is not bad for certain things if quite uniform throughout, but it draws the temper of drill.

It was stated under the article on the dome chuck, that the possibility exists of working certain

dome designs without this chuck at all. This is done by the use of the eccentric cutter fixed at an angle of 45° to the work. Thus, when revolved by hand, the tool, which must be exactly up to centres, touches the centre, or point, of the work, and the centre of the circumference. The work can be shaped, first by the hand tool to roughly a half sphere, and then, when the cutter is fixed as just described, it can be revolved slowly with the hand on the mandrel, and the cutter will keep shaving it off till by the completion of the revolution the perfect sphere is formed. The tool used is a round-nosed one. Now polish the work with stiff brush and dry wax on it. The cutter can be exchanged for any other that is required for cutting the pattern by removing the tool and replacing another, without moving the slide rest setting, and fixing in with the new tool touching the work. This gives the correct radius which could not otherwise be got.

In the section on drill spindle manufacture (which see), it was stated that a certain size should be used to bring the tool always to centre, but for some designs it is an advantage to have the shank slightly less if the same spindle is used to carry the eccentric cutter, as for certain work the tool has to stand below centres. In Mr. Evan's work, Vol. I, p. 144, he refers to a design cut with the tool above centres, and then suggests that if the tool is lowered to exactly the same depth below and cut again, a most beautiful effect will be got. Now as many will run the eccentric frame on the drill-spindle, *a smaller shank* will allow of this lowering. If a piece of packing, always kept for this purpose, is made to make up

the distance to bring up the shank to correct height for ordinary drilling tools, it will be just the same. The worker must judge which he will do.

Referring again to the dome chuck work, it should be added that the reader may imagine that the same result could be got with the work horizontal upon an ordinary chuck, and the tool adjusted relatively; but in the former case the slide-rest can be used to give travel in a straight line, hence a straight moulding can be got, whereas in the latter case only a curve could be cut. This will be understood when put into practice. A revolving tool presented to the work and penetrated, will cut a *concave curve*, but the same tool, if traversed *up and down through the same cut*, will take out the curve and produce a *straight line*.

A very pretty effect could be got by first cutting out a dome (as above described), decorating it with grooves and then parting it off at exactly the half-sphere line, making an exact half circle. On the lid of a box cut the twelve interlacing eccentric circles, as above described, and then make a recess in the lid to take this dome, and glue it in place. Leave enough room in spacing the eccentrics to give a small margin round the dome, and run an angular groove round it. This is illustrated in the group, Plate XIII, Fig. 7.

In cases where irregular countings have to be made it is well to use a pencil and paper and make sure first that the countings will work out equally. So in the case of eight moves on the 96 wheel, and then four moves, and so on with eight and four

alternately, we must be quite sure that there will be an equal number of each. Here is the check set out on paper: $\frac{96}{8}$, $\frac{8}{4}$, $\frac{12}{8}$, $\frac{20}{4}$, $\frac{24}{8}$, $\frac{32}{4}$, $\frac{36}{8}$, $\frac{44}{4}$, $\frac{48}{8}$, $\frac{56}{4}$, $\frac{60}{8}$, $\frac{68}{4}$, $\frac{72}{8}$, $\frac{80}{4}$, $\frac{84}{8}$, and $\frac{92}{4}$. There are eight of each. This principle can be used to test triple or quadruple arrangements, or any other number.

Cutting letters and figures.—These can be cut with a "diamond" point revolving in the drill-spindle, the movements being governed by the segment engine and the cross slide. The work is faced first and chucked, and the lettering marked, or drawn, on. A stop is fixed to the top-slide to determine depth of cut, and then the cross-slide can be worked to and fro while the mandrel can be revolved by hand, also to and fro, so that the revolving tool follows the lettering. It seems to me any free-hand design can be worked similarly. It is also possible to remove the work when faced both sides, and move it about against the tool by sliding about over the face-plate; but it would be more tiring to the hands, and great care would be needed. Of course deep cutting could not be held in this way.

When the letter "O" occurs I take the trouble to set the eccentric slide to work, which does it perfectly. Such letters as "M," with the lines forming radii to the centre, can be cut with the cross-feed and segment engine very easily. Thus "M" would be like this $\geqslant$.

It is so puzzling to an ordinary turner to be told that it is quite as easy to turn a square, or a hexagon or octagon, or any irregular shape, as it is to turn a cylinder, that I deem it advisable to say that the

shape required is turned down from a cylinder, turned in the first place to size, and large enough to turn out the size required in the finished square, etc. To determine the size exactly of any *circle* from which a square of given size is to be cut, draw that square on paper and describe the circle about it, exactly cutting the corners. This gives the true diameter, from which, with one diameter line drawn through, the calipers can be set. When the work is fixed the eccentric cutter with its round-nosed tool at a radius large enough to cut the corners square is set to work along it and a flat side is produced. Four moves makes a square, six a hexagon, eight an octagon, and so on. This will make it clear. In Mr. Goldsworthy-Crump's articles there is a method of turning square pilasters. (See *The Model Engineer*, July 22, 1909) which are not really square. Where slight curves are allowed his method will do, but where absolutely straight faces are required the method above must be used. Mr. Evans deals a lot with square work in his books. A further remark should be made about mouldings about square work. If these, too, must be free from curvature, then the dome chuck or the makeshift (see back "dome chuck") must be used, for the reason explained that the cross-slide can be used to actuate the tool, and the work shifted up and down into position; a thing which cannot be done when the work is horizontal, unless the vertical slide carries the tool, which then can be worked up and down to produce a straight line (see above remark on revolving cutter).

It is explained in another chapter that rings can be

saved from hollows for further use. In designing, these rings can be fitted to shoulders of other coloured woods and turned with them, and patterns cut, thus forming delightful contrasts in coloured effects, etc. They should be glued on. In truing these rings great care must be used to prevent their splitting, especially if they are of cocus. If a ring is driven on tightly the strains will split the ring when some has been turned off, but the following plan will prevent all this. Make the ring an exact fit on the box plug and just push it on. Then remove and use some "Fortafix" cement and push on again. This sets in a few minutes, and will hold the work if it is turned carefully. These rings, too, form excellent collars to join together parts of ornamented goods that cannot be fitted with shoulder and socket. In Plate XIII the reader will see that the small vase is "collared" just under the bowl. As the top of pillar was a shoulder and the under side of bowl could not easily be bored to take it after being parted off, a small shoulder was cut on it, before being parted off, of just the diameter of the other and the collar fitted. This dodge will often help the amateur, and is a wrinkle well worth including in this work.

The author has tried to think of an idea, better than the one given elsewhere, for the effectual chucking of ivory nuts. The following is one idea, not yet tried. Make a box-wood cup chuck and fill it with plaster of Paris made to a consistent degree of plasticity, and into it press the nut, and let all dry together. Another idea is that of making a cup chuck with an outside screw taking various sized

washers to accommodate various sizes of nuts, the only objection being that less than half would be allowed to protrude, else the washer would not hold.

Still another idea presents itself, viz., that of a mixture of glue and sawdust, allowed to set hard, and used instead of the plaster of Paris. Of course a very simple way is to file a flat on any desired part, and glue the nut to a flat wood-faced chuck.

Designs which may or may not be worth the trouble of executing, can be tested by means of pencils. A paper surface can be temporally attached to the face of the work, and the whole traced over with the pencil in place of a tool. This expedient will, however, only be necessary for the beginner who is learning "the tricks of the trade."

Full details have been given of the way in which flat facets can be cut on certain kinds of work. If, however, the drill-spindle is fixed to the vertical slide on the slide-rest, and worked up and down during the cutting, flat work will result. Work placed on the centres can thus be worked with square facets.

Any kind of varnish or French polish on ornamented work cut in good material is objectionable, making it at once common in appearance. It is the ambition of the artist to finish his work with the tool. But at the same time there is a polish sold by Mœller and Condrup, the poker-work people, which is not open to this objection if used very sparingly upon a medium stiff brush, and the work brushed over either on or off the lathe. It imparts brightness without the suspicion of polish. It does not clog the fine cuttings.

Marking zeros on the lathe.—A complete set of

zeros is of infinite value to the worker. Suppose a piece of work gets shifted, and has to be removed for resetting, or again, a piece being studded, or otherwise treated, has often to be removed and replaced, it is an advantage to be able to set the lathe in exactly the position in which the work was started. Here is the method. Fix the segment engine, or count wheel in a known position, and then note a certain cog in the mandrel and nick it. Against this place a punch mark on the head-stock casting. It means that at any time you can fix the mandrel and segment engine and counting apparatus in the same relation. Now add further marks on the plug and its taper fitting, or chuck, etc., as the case may be, and the mandrel nose, when all are in their final position. Besides the above explained advantage, there is the additional one that if a miscount is made or any doubt exists a return can be made and the whole restarted. Now to complete the business, the tool-holder must be subject to the same treatment. A flange sweated to the side to engage with the edge of tool rest will secure this. It should be added that a mark on the work and on the plug where they unite is also an additional gain.

CHAPTER VII.

TURNING MEDALLIONS IN COLOURED WOODS.

Dr. Audsley's work, mentioned in the bibliography, contains some valuable information on the making of beautiful specimens in different varieties of wood. But the author wishes briefly to give a little information on the subject of his improved method of chucking, etc., a system brought to perfection in the attempt to make some of these medallions in various coloured woods. In the chapter on "Chucking" directions have already been given along these lines, but the following may be considered the best of all the methods suggested. Suppose it is required to make a coloured inlaid medallion in three coloured woods or materials, as many chucks will be required as there are varieties of wood. Now, if "cup" chucks are used, they not only will be more trouble to fit up, but will add very greatly to the cost—an item! The total cost of 12 plugs—really chucks—with the taper fittings whereon they screw, will be 1s. First procure an old solid saddle-pin at a cycle shop, or a piece of mild steel, and turn up first of all a taper on one end to fit the mandrel nose. Make it a perfect fit. Drive it in gently with a wood mallet, and turn it down to give the exact diameter for a thread, 19 to the inch, till anyone of the 12 penny sockets—known as $\frac{3}{8}$ in. gas iron sockets, which have an external

diameter of a little over $\frac{7}{8}$ in.—after a thread is cut about $\frac{1}{2}$ in. along it, terminating in a square shoulder—will screw on a perfect fit. Fig. 1A, Plate VI., is a full-size drawing of the whole tool. Upon this all the work can be done and no other chucks are required. Now to prepare the chucks, or plugs, take one, screw it on and true the end across, and turn out the end slightly bevel on the inside; this will allow the plug, now unscrewed and reversed, to be screwed home to the shoulder. Now turn the other end true, and the body also, till a nice finish is obtained. Now reduce the front end to $\frac{13}{16}$ in. to form a shoulder from $\frac{1}{4}$ in. to $\frac{5}{16}$ in. long. This is quite enough to hold. Do all the 12 in this fashion, and you have 12 chucks ready. The work is speedily done.

Now to affix the boxwood to each. Place the four dogs on the large face-plate, and screw on to the mandrel nose. Cut as many pieces of boxwood as are required, say in 2 in. lengths. Just trim off the bark, and then chuck on the face-plate. True the end, and then with the tool (Fig. 4, Plate VI) make a hole $\frac{1}{4}$ in. deep and very slightly less than the $\frac{13}{16}$ in. plug, so that when removed, the plug can be driven in with a wooden mallet. Do not use a hammer. Each piece can be fixed thus to a plug. This is all. Each piece can then be turned on its plug and the end faced.

When the reader is fitting his plugs to the taper fitting remember first to clean out the thread, as these things are generally rusty and dirty, and would spoil the truth of the work if machined with the dirt in them. A heavier fitting, made as the result of later experiments while this book has been preparing, is

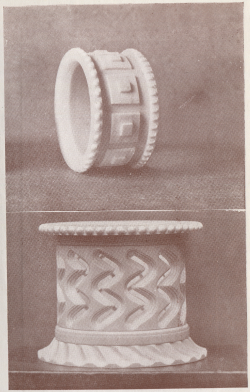


PLATE XIIa.
Further examples of Serviette Ring and Small Open Casket.
(Plate XIII. is on front cover of book: see Notes in Appendix.)

(*Facing page 72*)

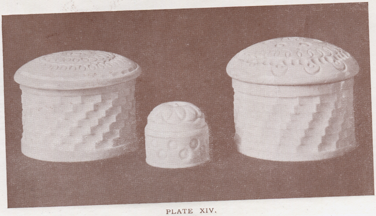


PLATE XIV.
Examples of the Decoration of Ivory Boxes.

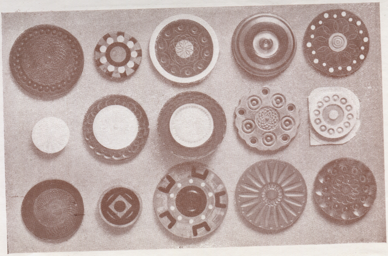


PLATE XV.
Examples of Ornamented and Inlaid Medallions.

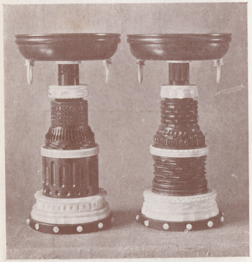


PLATE XVI.
Vases in Blackwood and Ivory.

described in chapter iv, where it was inserted in the "making-up" of the final proofs. This fitting answers the same purpose as the above, but has two advantages over the taper fitting, viz.: (1) that, being more solid with the lathe, and (2) that of less liability to get loose in the heavier cutting and decorating. A taper, however, holds well when it is a true fit, in its place—otherwise it will not hold at all and will soon wobble out. If, then, you make the taper fitting, give time and care to the production of a *perfect fit*.

Wood thus mounted can be cut direct into boxes, box lids, etc., and ornamented, with the advantage of knowing no big chuck is in the way of the cutters, etc. Or the boxwood can be used as a chuck upon which turner's cement can be used to fasten small pieces for turning, etc., or shoulders can be turned down for lids, etc.; in fact, they serve in a great variety of ways. Cobbler's wax is also good to use.

Now in this medallion work they are specially useful, as the piece being inlaid can be unchucked, *i.e.*, unscrewed from the taper centre when it has had its largest recess cut on its end, and held in the hand while the piece to be let in is being turned and tried against it for size, and when the hole will just go on with a perfect fit the piece can be parted off and then glued in. Replace the medallion piece again, and turn the next recess and simply repeat the whole process. I am here assuming that the medallion piece is a piece of say, rosewood, and the first inlay boxwood. Then if the second inlay is again of rosewood, a second piece of this wood is mounted on a plug and shouldered down, and so on with all the different

varieties. If certain kinds of wood are in thin boards, such as fretwood, circles can be cut out roughly and secured to the faces of these boxwood chucks or plugs with the above cement and then turned to size. Another plan, where a small hole in the centre is permissible, is to fit a small screw to the centre and screw up a washer against the wood and that will hold it. Facing off is done when all the pieces are let in, so it does not matter about facing the pieces; it is only necessary to get them truly circular, and true fits in their recesses. A press in fit will enable you to go on recessing while the glue is still wet. If medallions are made with concentric circles only, all the work can be done on the taper fitting, but where the more elaborated ones are attempted, such as eccentric circles let into the others, then the plug with the medallion piece on it must be turned each time upon the eccentric chuck. The others need not, but can be, if it is not pleasant to keep removing and replacing the eccentric-chuck and the taper fitting. All this writing seems to be confusing, but the actual practice to which it refers will be found to be pleasantly easy. A word in conclusion respecting medallions. Do not finish them till the glue is dry. They then finish well, and can be polished right off.

If medallions in coloured woods are all on the very hard side, various ornamentations can be cut in them, and if suitably done, will greatly enhance their beauty. Say, *e.g.*, a medallion consists of light and dark rings, with four, or three, eccentric circles let in of a light colour, box or ivory, these latter can be cut with four or six or more eccentric circles, or interlacing con-

centric circles cut with the cranked drill or eccentric cutter, and the others all left plain. In no other work has the author seen this even hinted at, much less done.

Other effects in coloured woods.—Two further ideas will here be given as suggested to the author by: (1) the Rev. James Lukin in his work, "The Lathe and its Uses," in his article on Tunbridge ware, an art which consists of lengths of square pieces of various colours glued together, and either turned in lengths to form coloured cylinders, or thin slices cut from the ends to form coloured inlays, either square or round. In the latter form they would resemble the inlaid medallions, though produced in quite another way. This would be a good way of making medallions when a number would be required, all of one pattern. But the design would be in squares.

The author suggests that an additional beauty can be imparted to the cyclindrical work produced in colours by transverse studding, *i.e.*, when the rod made up of square section pieces is centred in the lathe, it is bored through at right angles to its length and fitted with plugs of wood of another colour or shade, and then turned. The effect would be that of a striped cylinder with circular spots of another kind of wood, a thing that would give great beauty if nicely selected.

(2) The second procedure differs quite from the others. While on holiday the author was shown a cigar-case made more than fifty years ago. It was done in this way—in this case no lathe at all being used—a mandrel was made of deal and the edges

rounded. Two layers of veneer were softened and rolled round, the edges tapered off and glued and bound, and the whole set up to dry. When dry, another mandrel, larger than the first by the extra thickness of the veneers, was also treated with two layers of veneer. This was the outer case. Upon a thin slice cut from the end of each mandrel a series of coloured woods were glued, about $\frac{1}{16}$ in. thick, and pressed till dry. Then they were rasped or cut off slantwise in every direction, the result being a series of coloured superlays giving a most pleasing effect. These ends were then glued in, the whole glass-papered and the final polish put on.

Now this idea the author has tried for small and large medallions for box lids. Lids can be built up in this way, boxwood being perhaps the best foundation. But the foundation in any case will consist of the wood that forms the lid. It is quite obvious that no such lid can be flat, but oval, or semi-circular, or any other kind of curve that will give best effect to the woods used. Let it be remembered that an inlay medallion lid can be made not only flat but also raised in this same way, though a little more trouble to do. This method of super-position is much the easier of the two, requiring much less skill. To summarise, the above methods can be called medallion work by inlaying, superlaying, and square-sectional, inclusive of studding and incising. This gives great variety of effect, the value of which will be estimated by, not the multiplicity of methods used, but by the combined effect in each case.

In selecting boxwood for medallion work, choose the best grained. This will be found in the "knottiest" pieces generally. Now all ornamental turners know from bitter experience that "knotty" pieces will not do for incised patterns, particularly on the outside or circumference. This being the case, a very good use can be found for these rejected pieces as above stated. When let in, the edges do not show, and all surface imperfections can, by arrangement, be cut out for the inlays. Very pretty wavy lines occur in knotty and irregular shaped pieces, and there is more visible grain than in the more regular ones.

For medallion inlaying, the quickest, and, perhaps the best, way of preparing the inlays and the patterns is to decide the sizes and numbers of same—make a drawing if necessary—and cut them all out first and have them to hand. Then, as the recesses are cut, one by one, the pieces can be tried until the recesses take them with a snug press in fit. As each piece is ready for insertion, unscrew the plug with its piece and, after glueing the edge and undersurface of the inlay, press it home. If it is a wee bit too tight for the fingers to get it home, it can be forced in by screw pressure equally applied, but in no case must the plug itself be touched, else it will shift. Do not hammer either, as this will tend to jerk it loose. For this reason also is it removed from the lathe.

Inlaid rings, let in eccentrically can be best worked by cutting out a cylinder of the size and boring it out. To get a good fit a template should be made to get the exact thickness of the tube. Now, if in this template, consisting of a piece of flat mild steel, two notches

are cut, one exactly matching the width of the tool used in the eccentric cutter to cut the recess, and the other notch just the least bit wider to allow of a tight fit, this will ensure perfect fitting work. One template will do for all sizes of rings, but different ones will be required, and recessing tools to match each, for all rings of thicker or thinner dimensions.

For these rings, and also for the above-mentioned medallion inlays, it would be a saving of time and labour in the end to cut out of zinc a series of templates of the sizes to be used which could be slipped over the pieces being turned. They can be cut in the lathe. Hence uniformity of result. A handy arrangement where several medallions are required alike.

A circular saw, running in the spindle of the Universal Cutter Frame, is an excellent tool for parting off, or slicing off, rings or discs, as, besides the saving of material, owing to the thickness of the saw, there is less chance of damage than with a parting-oft tool. The author runs his on end of *large* drill spindle.

In very accurate work (*e.g.*, Tunbridge ware) in coloured woods in combination to form a pattern the cutting of very thin veneers is a difficult job on the circular saw table, and is specially dangerous to the fingers. The writer has tried with success the following: The large face-plate is fixed on the lathe nose, and the angle-plate attached in a horizontal position. Upon the latter a piece of truly squared wood (deal will do) is fixed, upon the outer edge of which is glued the piece from which the veneers are to be cut. The saw is fixed upon the drill-spindle truly square with

the work. Now by using the screw as a measuring tool the veneers can be gauged very clearly and accurately. Another way is to use strips of metal of the same thickness as the veneers, and using a stop on the slide. Each time a cut is taken the stop is screwed back till the metal strip will just pass in. Any inaccuracy in the screw will then not impart itself to the work. This same dodge could be used in setting a tool for basket work, etc., using a piece of metal equal to the width of the tool. If the above plan is preferred the series of coloured woods can be glued either upon one piece or several pieces. A very fine saw should be used. A true steel rule can be set against the face plate (or face of work, if true), and the saw adjusted to it. All guiding by hand is, by this method, eliminated, and perfectly parallel strips will result. Veneers from $\frac{1}{12}$ in. to $\frac{1}{4}$ in. are best cut in this way. The saw must be either above centres with the teeth from the operator and revolved in that direction, or below (whichever is most convenient) with the teeth towards jaw, and revolved towards jaw. In each of these cases the centre of the saw is kept clear of the work.

If any worker should find it difficult to cut accurate strips for letting into prepared grooves, when straight work is in progress, let him remember that an easier course is open to him. He can make circular pins with the punches (elsewhere explained) of such size as corresponds with the width of the groove. This will lay in the groove exactly touching at bottom, and at the half line. They can be glued in. If some powdered wood dust of the same wood

as inlays is mixed with glue and put in first and the wood pressed into it the job will be as secure as if the pieces were square. But one must also bear in mind that such pieces will bear very little facing off as no cutting must go below the centre line, and this facing must also be accomplished when the work is dry and firm. With square inlays, however, we can proceed at once, so that they have the advantage after the difficulty of cutting them accurately is overcome.

In connection with ornamentation by means of coloured woods, properly plain turning, there is one thing more to be said, and that is in regard to the method of eccentric inlaying, viz., the letting in of various rings eccentrically. The concentric rings are finished first, and the centre is left plain, and large enough for the placement of the eccentrics. These may be three or four, or more. I am speaking at the moment of the lids of boxes or medallions. Now as the grooves for these rings are cut with a cutter that makes a channel into which the rings must accurately fit, the best method must be adopted of getting these true to size. The following is the author's way of making the best of a difficult job—his latest way.

The plug holding the piece being worked upon is fixed upon the eccentric chuck and turned true all over. Next the outer rings are turned and fitted. The centre piece is then let in of such a size as will allow correct spacing room for the eccentric rings. The size and thickness of these is now decided upon. The tool which is to cut the grooves is a chisel-ended one, fixed in the holder and presented to the surface

of the work, and this will enable the exact size and position to be seen by moving the eccentric out or in till the setting is correct. We now must be able, having made the first recess, to determine the exact size also of the piece to be let in. Turn up a ring, the hole in the centre of which is a bit larger than the inside edge of channel, and then turn the outside to a press in fit. This is the outside gauge. To get the inside correct, make a file slot in a piece of zinc or mild steel plate, of the width of the groove in the work, *i.e.*, of the tool which cut it. Now when the piece that is to form the ring to be let in is of correct outside diameter, keep reducing the inside till the gauge just fits over. The ring can now be carefully parted off, and will glue in perfectly into its place.

The best way of holding these rings is to place a piece of flat wood against a wood-faced chuck charged with turner's cement. It will be noticed in the illustration (Plate XVI) that the inlaid rings are studded. This studding was done before the rings were cut off. The studs are very small and cannot well be turned. They were made with a small saddler's punch, the wood being cut down along the grain in short lengths. A good punch will make them perfectly. A drill was made to bore a hole they would just fit tightly. If the turner cares to take the trouble he can make a very efficient tool by boring a steel cylinder of the size required, and cutting teeth on the end. This would cut the little studs very cleanly and accurately. A spiral of these little studs let into a box of coloured rings would look very pretty, winding themselves

around the box from bottom to top. Another way of preparing the grooves is as follows :—

If a set of radius drills with chisel ends, described in drawing (Plate VIII), be prepared, then, as these always cut the same circular groove in any position, it will be clearly seen that a few of these of various radii, each having a zinc template cut for the size of inlay, and a notch in its edge for the gauge of the tool width, a great variety of work can be done as described in the text. The eccentric cutter frame could be used, but would give more trouble in setting the cutter. It would be advisable, if the worker selects much of this work to do, to make a heavier drill-spindle to give greater power to the recessing tool. A geared drill-spindle would be the thing to use, if one is possessed.

A superb tool for the above work, a fitting that could be made to run upon the drill-spindle, is a hollow cutter of the size and thickness of the rings with teeth on its end (similar to the one for cutting small pins or studs). If the back end is made to screw on the drill-spindle, this will drive the tool and the template can be made with the same cutter in a piece of hard wood. Two or three such tools made from tubing of various sizes, trued up outside and inside, and case-hardened, would answer all general requirements.

This latter idea is only theory with the writer, but will have become practice ere this book is published.

It has been previously suggested that fine effects can be got by glueing together square pieces of wood,

as in Tunbridge ware, and cross studing them. If now, instead of using the same as cylinders when turned up, it is desired to make thin discs for inlaying, the saw comes in splendidly, as there is so little waste and quite a flat disc is secured, a thing not so easily done with a parting tool if held in the hand. Further, when arriving at where the studs pass through, a different design will appear, which will vary with the cutting from the edge to the middle of the stud, and past the middle to the outside again. Thus, if a number of discs are cut off, there will be a variation in the series, and yet the pattern will be, in the main, the same. This effect will be a gain in the arrangement of artistic patterns.

Just one other suggestion may be added—others will come out to the worker readily as he gains experience —and this is the suggestion: If a medallion is being prepared of concentric circles, with small eccentric circles let in on any part of its surface, these small circles can consist of these sliced off, vari-coloured discs instead of being just plain wood. This will give great sparkle to the work, and add greatly to its beauty. A note of warning must be given here as regards the preparation of these "made-up" discs. In cutting the square lengths of which they are prepared, be careful to see that all inner surfaces will admit of close contact; also that they are well glued, and well pressed together till quite dry. If not, when sliced off they will be gaping at the points, and in all probability tumble to pieces.

It will be seen that the reader has three kinds of small inlays described. 1. Those consisting of plain

pieces turned to fit their recesses. 2. Rings cut from prepared cylinders and let into grooves. 3. Made-up discs of coloured wood. To these a fourth could be added, viz., by exactly turning a cylinder of the No. 3 kind, and glueing it into a tube of the No. 2 kind. The resultant discs would then have multi-coloured centres with an outward ring of one colour. The greatest care is, of course, needed in handling and fitting them into position, and as they are thin, they are best fitted finally and the recesses made slightly deeper than their thickness, so that when the whole medallion is faced off, these thin discs are not cut away altogether. One-eighth of an inch thickness, generally speaking, will give room for play.

Old ivories from piano keys are useful for small inlays, but they must be let in after the whole medallion has been polished, as they are polished with a rag and damp whiting, and finally treated with a soft rag or buff.

One certain way of getting perfect fitting rings not requiring templates, and accommodating itself to every size of ring, is as follows: A stop is fixed across the saddle in front of the tool post. To this is affixed a stop which can be placed, removed and replaced without fear of alteration in the least degree. This is necessary to allow of movements of the tool in cutting as will be seen. Now, having fixed up the work on the eccentric chuck decide the first ring, and with the chisel-tool in the holder make the first groove. Fix the stop. The tool-holder must have a flange, so that if it has to be removed it can be replaced exactly. A piece sweated on the off side

which engages with the edge of tool rest will do. Now slide back the rest and unscrew the eccentric chuck and work, and mount a piece of hardwood and face up, and then with "turner's" cement affix one piece for ring No. 1. Now slide the rest up again, and the tool and stop being in position just make a cut deep enough to give exact size of the groove cut in the work. Next, take the tool to the inner edge and cut down to a little deeper than the thickness of the ring, then remove the stop and bring the tool the other side (next the operator), and set it exactly, and cut down again. A ring will project exactly dimensioned to the recess in the work. Do all the rings at once, and part off with saw as above. If the rings are to be studded, drill the holes before parting off, and glue the studs in, just filing the ends to prevent their damaging the hole. Trim all off close, and file down level. Now insert ring in the work, and proceed to cut groove No. 2 by refixing the eccentric chuck, and all will go along. If a ring is just a trifle too tight, split it with a keen chisel, slice a bit off and the ring will go on in two halves. Before parting also run the tool to the edge and see if the ring and tool coincide. A caution must be added. When the rings are pressed in and they stand a trifle above, file the surface down level; it is better than turning, being less liable to damage. All is then filed and *finished* by turning and polishing.

Square inlaying, etc., in coloured woods.—Although the author has written already somewhat fully on coloured work and inlaying, there is nevertheless just another field open to investigation which

must be explored, and a few suggestions will enable the worker to much increase the scope of his productions. The plate of medallions will include an example or two of this work.

A square inlay.—Assumed that it is required to let in a square into the lid of a box or medallion the following will give the method. An "end mill" (listed in Adam's list at 6d. for $\frac{1}{8}$ in. or 9d. for $\frac{3}{16}$ in.) is the best tool to use. Fix in drill spindle. This tool revolves in this position from the operator. To get an inch square the spindle must be packed up $\frac{1}{2}$ in. To locate the square correctly, place a pencil in the spindle and run it across just in contact with the work, give a quarter turn and repeat, and so on for the square. Now replace the tool and insert, say, in the middle of the square, *i.e.*, in the middle of the line, it will cut the line and stand $\frac{1}{16}$ in. above if $\frac{1}{8}$ in. cutter is used. Remove chuck with work and rule a $\frac{1}{16}$ in. line all round. Replace, and now proceed. If this pencil mark is not used it will be more difficult to get the work true. To be effective the square must be a square and not have any corner bulging. The stops can be placed if necessary, and will perhaps make the work even more secure from error, in beginning and finishing the cut. They are fixed after the first cut is taken. These end mills cut a very clean groove, and bottom it cleanly too. They make also very useful tools instead of drills for studding.

The inlays can be cut with the circular saw and carefully inlet, either mitreing the corners or fitting them straight, as, if pressed in well and closely, they

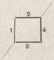
look like one piece. This should be aimed at. In fact, the squares could be cut in one piece out of solid, as directed for the rounds, if the trouble is taken, but being straight the work does not present much difficulty. If the round corners are left from the tool the inlays can be filed round to fit, or a sharp chisel can be used to cut them square. Use a wide chisel and the inside edge of groove will keep the blade true.

Another way is to leave the corners, and after the inlays are in, cut a circle through the corner and let in a disc of another colour. This is very effective. If the worker has a vertical slide this accessory can be used to fix the work upon, and greater movement can be got where larger surfaces are to be dealt with. The mill is then, of course, run in the lathe. The eccentric and dome chucks can also be requisitioned, and add to the variety of work.

Square inlays in round, cylindrical work.—It is possible also to greatly relieve the work of sameness by adopting this plan.

Around the finished cylinder place a band of good paper, overlap and cut through with keen knife. This will give exact circumference. Cut into four. The strips will give the quarter distance. Say the cylinder is 3 in. round, then the squares will be, if four are decided upon, $\frac{3}{4}$ in. Now this will give the lateral travel of the mill. The cylindrical travel is determined by the count wheel if one is on the lathe. Having determined by pencil lines the positions of the squares along the cylinder, cut the first slot by running the mill in drill-spindle up to the pencil line,

giving $\frac{1}{4}$ (or if you have a segment engine or count-wheel use that) by turning the mandrel in the right direction by hand. Now stop and begin the lateral cut (Cut No. 2). Return again to the starting point, and take the next lateral cut (No. 3), and finish with the final cut. This diagram will explain.



The reason why Cut 3 is begun in Cut 1 is this: if it were continued from end of 2, the mill would be cutting backwards in the final lateral cut. It will cut either way cylindrically, but not laterally. All this will be clear in practice. The squares can be in straight lines down the cylinder or placed spirally, of course, using the count wheel. The pencil lines all round will facilitate this. Do not forget that besides squares all sorts of other patterns can be cut by proper arrangement. Triangles, hexagons and octagons, etc., can all be equally well cut. Segments will, too, often be becoming in a space in which no other ornamentation would look well.

The author has never seen the latter ideas in any work, in fact many of these suggestions will be found to be original, anyway so far as their publication in books is concerned. He has never seen them either in practice.

Save all clean fine cuttings and saw-dust from the fly-cutter and the saw, and box them up. These

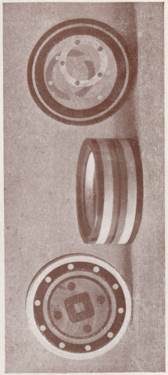


PLATE XVII.
Inlaid Box with two Patterns of Lids.

(Facing page 88)

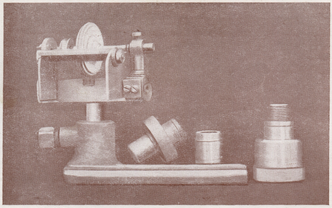


PLATE XVIII.
A Grinding Jig and the Screw-on Plug Chuck.

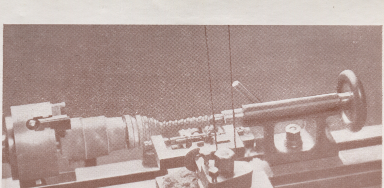


PLATE XIX.
Showing Spiral Apparatus at Work.

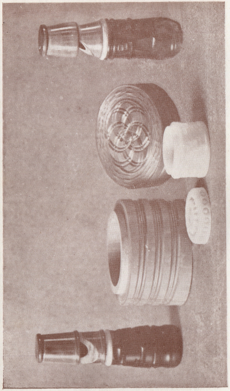


PLATE XX.
Two Boxes and two Wooden Whistles.

ground in mortar with a pestle, and mixed to the consistency of cream with glue will do for inlaying irregular designs with the natural woods where the solid wood could not be fitted. If made too thick, granulation shows, but a moist mixture settles into itself and shows no granulation. Work the wood well both in the dry and mixed states in the mortar.

Reference has once or twice been made in the text to the use of rings of wood for various purposes. Some of these are the "wastes," pieces cut away by a special tool for the purpose of further use, also to avoid the extra mess of shavings and dust. But for certain kinds of work rings cut purposely are used, and Messrs. Hobbies, Ltd., of Dereham, supply fretwood of good quality at from 2d. to 10d. per square foot, which is sufficiently accurate in regard to parallelism of surfaces to afford the means of quickly cutting and turning circles of the required thickness and diameter. Especially useful are these pieces when a rather large diameter is required, as it is very awkward to cut off rings or discs of material in hard wood from heavy pieces fixed in the lathe quite solid. If the fretwood is purchased already planed the surfaces will show no appreciable error, and will need no surfacing—a great save in time. It will be best to give an example to illustrate more clearly what is meant.

Let it be supposed that a box of vari-coloured rings is required, 3 in. in diameter. Proceed as follows: First, select the wood, say in 3 colours. Draw with compasses 3$\frac{1}{4}$ in. circles, and cut up the number required. Through the centre of each bore

a half-inch hole. Now chuck a piece of hardwood thus prepared: Take a piece of mahogany or beech, and bore a hole about $\frac{5}{8}$ in. or $\frac{3}{4}$ in. in one end. This will allow hold for the jaws of the chuck tightened outwards. Make the hole deeper than jaws of chuck to allow of a nut. Chuck up and face off the end, leaving an half-inch shoulder slightly thinner than the thickness of the wood being used. Now get a small screw and nut. Make a small hole through to the hole inside. If the nut is recessed in, it will hold in position, and not necessitate the removal of the piece each time a ring is turned. Now with this piece in the chuck, take the first ring and place it over the $\frac{1}{2}$ in. shoulder. Put a washer on the screw, and screw it home. The washer will force the wood against the face of the block, and hold it till turned. Turn all the rings in succession 3 in. full. Now fix the four-jaw chuck on mandrel nose, and taking each ring at a time, fix it in chuck and turn out the centre, slightly less than the finished diameter of box. (Save these smaller rings, they will come in useful). Now arrange in order, and glue all together, and place in cramp or vice, and see that the pressure is central. When quite set chuck the part that is the bottom end on a boxwood chuck shouldered off to take the hole. Make this a good fit and glue in position. Proceed to surface the outside and cut the inside to size. True up the end and recess the end for the lid, as the lid is fitted this way to avoid spoiling the design, a thing that would happen if the lid were fitted as ordinarily upon a shoulder cut on the box. In this case the lid will drop in, and the pattern of the rings

can be completed with the lid. Now finally polish (unless any ornamentation is to be added) and part off. The piece of box will then form a let-in bottom, and will not affect the design in any way, and leave no chuck marks.

Another method of mounting or chucking the coloured rings for turning them is by placing them all together in the order in which they will be placed to form the box upon a mandrel, and turning them all up together. The mandrel should consist of a piece of $\frac{1}{2}$ in. mild steel with a screw-thread along its length. A short shoulder should be left one end for the self-centreing chuck to grip it, and a centre pop at the other end. Of course, if the screw is cut in the lathe there will be a centre at each end, in which case it can also be driven with a carrier, if preferred. The pieces are threaded on this mandrel, and a nut and washer at each side bind all firmly together. Each piece, after turning, can be placed in a recess in a boxwood chuck, and the tool fixed to the correct radius in the slide-rest, can be advanced each time, and cut the rings all to size. It is not particular, however, as the rings are trued up finally, as described, when all are glued together.

In preparing thin wood discs for building up boxes, serviette rings and dome lids for boxes, etc., the best way is to mount the circular saw on the drill-spindle and fix to slide-rest and set it true. Then, having previously turned up the cylinder to the size required, allowing for final turning to the finished diameter, revolve the saw, and the work towards you, and run the two belts at the same time. By rightly

fixing the belt from overhead to saw, the correct action will be obtained. By rotating the work the saw has only half the travel to cut off the discs, and bigger diameters can be negotiated than would be the case if the work were sliced across while not revolving. A fine saw must be used, and this gives nice tooth to the surfaces to hold the glue. Hence any wood can be cut up in this way.

When using the circular saw for parting discs there is sure to be a slight roughness at the edge, even if the saw has little or no set, and is very fine cutting. But if, after the saw has penetrated say $\frac{1}{4}$ in., a very light touch with the finest grade of sand-paper is applied, this will remove the irregularity, and the cylinder will not be reduced in size, a material point when these discs are to be inlaid straight away. There is no chance of trueing them up after they are cut off, but the roughness can be disregarded when they are to be used as superlays and turned up finally when in position.

Tissue paper is a capital workshop requisite, inasmuch as when one is fitting a serviette ring, partly done on to a boxwood chuck for finishing cuts and ornamentation and is made just a slight bit slack on the shoulder, a thickness of tissue will just correct the error. Perhaps two thickness will be required, but it is so thin that the exact amount can be got, and it has great gripping powers and the work is not hard to remove.

CHAPTER VIII.

Spiral Work—Miscellaneous Notes.

Cutting spirals on a screw-cutting lathe.—The introduction of spiral work into the composition of any ornament produces an effect which adds very materially to all the adjacent parts of the same, and the appearance of the whole. On ornamental lathes designed for that work alone there is fitted what is called a spiral apparatus, a very expensive affair. But this work can be done equally well on a S.C. lathe, and all the various pitches can be got by the use of the change wheels. The author is introducing this feature into the vases which form a part of the frontispiece group, and the necks of the vases will be seen to be spirally cut. Now how is this done? This way—a true cylinder is turned up to the desired size and run upon centres. Do not have a large chuck on the mandrel, as this will be found in the way of the final part of the travel of the cutter frame. The author shoulders the end to just the size that will screw into one of the plugs, and then this is screwed on either the taper fitting (Fig. 1A, Plate, VI) or the screw-on fitting which also fits all the plugs. The work being now in position, a cutter of the desired shape, pattern and radius is fixed in the universal cutter frame. If the cutter is set at an angle, or rather the frame which carries it, which will give the cutter the

right angular position, a wider or narrower groove, will be cut according to the angle set. The more the frame is set towards the vertical from the horizontal position the wider the cut. Now this is handy, as not only can a wide cut be done with a narrow tool, but the pattern can be varied if the cutter is, say, of a fancy character such as a stepped cutter. In such a case the steps would be deep on one side and shallow on the other.

Now one of the chief points to observe in this class of work is the providing of a sufficient speed for the cutter while the work revolves. If a coarse cut—for in reality we are cutting a screw thread—is being made, the travel of the slide-rest will be rapid, and the universal frame and its cutter will be carried along with it at the same rate, and perhaps do its work badly on that account.

The author, however, finds that what is a drawback in ordinary screw-cutting, viz., the fact that the change wheels being small on the lead screw for a coarse thread require great driving power from the treadle and strap, is an advantage here, for the handle on the other end of the lead screw will be found to move it easily. Consequently the strap is removed, and the rest and tool travelled along the bed as slowly as you like, at the same time keeping the relation between work and tool fixed. This gives the tool all the time required, and no bad work results. All the treadle motion then is applied to the overhead, and the traverse of tool along the work and the rotation of the work itself are governed entirely by the handle.

The writer sees no reason why this method of work

should not be an easy means of cutting coarse pitch screws with a milling cutter driven from the overhead. There is no disengaging of the nut from the lead screw, as the rest can be run back again by hand and a deeper cut made.

Serviette rings can also be cut in this special fashion, and the work has the advantage of being very quickly done. If a fine spiral is cut with a fine tool, and the frame fixed to cut horizontally, and the reversing gear used for the return travel, a series of long diamonds will result. A slight angular position, reversed for the return travel, will give wider and shorter diamonds.

A very useful application of the segment engine, in connection with spiral work, is that of using it as a *dividing* machine, when all other dividing schemes fail. Say, for example, it is desired to place beads, or any other design, round a flat spiral surface, the usual worm and tangent would be of no use for this work. But by shifting a peg from its last hole to the next given distance will bring the tool along—as it is worked while geared to the lead-screw—to its correct position. By such means a *non-continuous* thread can be cut with spaces left, which would form a nice pattern. The handle is worked to release the pin from its stop, and the latter moved the required number of holes and then brought back again on the stop and the work and tool are in position for the next cut. This will be appreciated by many workers when once tried and applied. (See last ring in Plate XII).

Spiral Turning with Curvilinear Attachment.—Mr. J. H. Evans, in his work of "Tools on Orna-

mental Turning," deals with a certain attachment called "the Curvilinear Appartus," which is fitted to the ornamental slide-rest, and is used for cutting shapes and contours, following a template, cut to the desired pattern. The author's description of spiral cutting of plain cylinders can be greatly added to by means of a fitting that will act as the above, and enable the spiral cutting to follow the outline of any vase, etc., being worked upon. The hand actuating the screw cannot be trusted to do this, and the following description of a simple piece of machinery will enable this most effective style of work to be performed with ease, and with this advantage over Mr. Evans', that a length equal to the whole distance between centres can be so ornamented, as the work is not confined to a short slide-rest. (See Drawing, Plates IX and XIX).

When any turner is led to the ambitious task of making his own furniture in view of a castle of his own, or to increase the value of the one he already has, this way of turning legs and backs, etc., is by no means to be despised. Spiral work is very pleasing, and very quickly done. Now for the tool itself. Two uprights of $\frac{3}{4}$ in. steel were made to stand behind the bed and slide-rest, so that the latter just cleared. On the writer's Milnes' lathe there is a pair of brackets for a shelf, which is used to support these pillars. A flat bar of iron is carried from one to the other about 1 in. × $\frac{1}{8}$ in., and is drilled with holes about $\frac{1}{2}$ in. or 1 in. apart to take the templates which are screwed to it. The slide-rest has attached to it a bar of iron, which is about 6 in. long, the other end of which is screwed to a sliding piece fitted to

work smoothly in the same V's with the slide, and keeps in advance of it. This piece is necessary to allow the slide-rest to come back to the operator's side of the work, at the same time putting the rubber or wheel engaging with the template sufficiently forward to do its work. Upon the end of this is the fitting which holds the wheel which engages with the template, and the thing is complete, except for a small pulley fixed at the end of slide-saddle to allow the cord and weight to work, and keep the slide in contact with work. The main screw (cross-feed) is removed, and the slide is worked by the cord and weight alone, which must be no heavier than is just sufficient to keep the wheel in contact. The setting is as follows: The work is fixed between centres and turned roughly to shape by hand tool and rest, and then the final finishing is done by working the rest along over the template with the handle fixed on the tail end of the lead screw, and the nut engaged as in screw cutting. A fly cutter is used, a round-nosed one, in the universal frame and driven from overhead. As the slide moves along it will cut the work true and smooth. Now fix the screw-cutting change wheels on, of the pitch desired, and the beading or other tool of the patterns of the spiral in place of the round-nosed one. Set in the cut, and travel as in ordinary spiral cutting (described above) and the slide-rest will again follow the pattern on the template, and the spiral will follow likewise. As a suggestion it would be well to try on a vase of small dimensions with a long straight neck and a globular bottom. The pattern looks exceedingly effective in

this way. A vase so done will be seen in the photographs in this work. (Plate XVI). Always work off the larger diameter to the smaller, there is less risk of catching.

In the case of multi-threads (a thread with several starts, for all spirals are screw-threads), a good plan is to divide the work at the start end (*i.e.*, back poppit end), into the required number, and start the tool upon the spot by disengaging the screw and getting into position, and then re-engaging it, removing the mandrel change-wheel the while. That precision required in screws is not required here, although any great deviation would spoil the work. But the writer finds it quite easy to set it this way. Moreover, it may not be required to use the same tool throughout and the position of a cut may have to be nearer to or further from the last one cut, according to the pattern required. A trial will make this quite clear.

It seems scarcely necessary to add that straight work, fluted, etc., with any of the drills and cutters can be executed with this same accessory. This only adds to its usefulness and the variety of one's work.

I see no reason why this method as described should not be used for fluting and otherwise ornamenting domes in the absence of a dome-chuck. It certainly would afford a cheap means of doing work by those who could not afford the latter.

It should be noted that all these spirals are *left-handed* threads so far. If for any reason the worker desires a right-handed one, the usual method of using the reversing gear will effect the same.

Now another word can be said on the method of *truing-up* the object before ornamentation. It is to the effect that instead of the fly-cutter after roughing out, *the ordinary fixed tool can be used*, and will be preferred by some, but there must always be coincidence between the centre of the tool with that of the cutter used after it to produce the final pattern. Especially is this the case when a drill spindle is used with a revolving drill. Always use a *round-nosed* cutter for this *shaping* process, as it is not possible to easily cut to follow a curve when a square or chisel-ended cutter is in use.

Of course, it need not be said by way of caution to any careful worker, that in the *forming* of the work the gears must be removed. Just the wheel on the mandrel will do, as then the revolving of the wheels on the lead-screw and quadrant will not actuate any part of the machinery, and will also be ready in position required for the spiral that follows.

In the writer's case, the use of the fly cutter brings the slide-rest so far back that the slide-rest tools have a lot of overhang, as the fitting does not allow of the moving up of the slide. A long tool, therefore, is used and is packed or blocked under the front end with a piece of hard wood, and it takes the strain. I shall, however, make an adapter so that any tool can be used—a plate extended out beyond the rest which can secure any tool upon it. The above remark only applies when the *fixed tool* is used for the shaping up, prior to ornamentation by spiral cutting.

A suggested appliance for cutting convex patterns upon cylinders by means of rotary cams on back shaft.—Two brackets can be fixed to the lathe bed at

the back, which support a back shaft. The shaft can be made to run either in sleeves or upon centres, the former for preference. Upon this shaft a cog wheel is fixed—a bicycle wheel will do admirably. This is fitted just behind the mandrel nose. A fitting is now made to screw on the mandrel nose, which will carry a cog-wheel exactly corresponding to the one on the shaft, so that they will perform one revolution together. Upon this fitting will also be fixed the work to be decorated. Now upon the back shaft behind the rest is fixed the cam or rose which is to decide the pattern. On the end of the slide rest is fixed a small upright carrying a wheel which engages with the rose, or cam, and follows its contour. To make the rest follow this treatment, the screw must be removed and a weight attached just heavy enough to keep the wheel in contact with the rose. It will now be seen that as the mandrel and work revolve a chain from the front to back cog will drive the shaft at an equal rate of revolution. The cam will now make one revolution in the same time, causing the slide-rest and tool to advance and recede as the pattern on the cam or rose. The tool must, however, revolve at speed being driven in the drill-spindle by the overhead. To give the tool all the advance in the matter of speed to aid clean cutting, let the back gears be put in, which will give the work a slower rate of motion.

By means of this apparatus, simple to make and easy to use, a great variety of convex work which would otherwise be impossible, except for the purchase or making of a rectilinear chuck, can be executed. Concave cuts are easy enough, being made

with a tool in the universal cutter-frame, but a convex cut is a different thing to do. Hence this suggestion. A variety of roses can be made for various patterns, and the diameter of the work proportioned to the diameter of the rose, so that extra cutting and waste are avoided. By this I mean, that if you start to work on a cylinder with a diameter in excess of the size of the rose, the tool would have to penetrate more deeply; therefore any excess should only be sufficient to enable the tool to cut clean out. It must not, on the other hand, be less than the diameter, for in such case a series of flats would be left upon the work.

Mr. G. Adams, of Holborn, will supply the fitting called plug chuck in Plate XVIII for 10s., made solid, and the plugs to fit at 2s. 6d. per dozen.

Note on Forming such Shapes as Vases, etc., for the Spiral Cutting against the Curvilinear Apparatus.—The author in the text forgot to say that to get the true shape (after rough hand-turning has made the thing approximate) by means of the fly-cutter in universal cutter frame with the rest run against the template, the correct way is to revolve the work backwards and the fly-cutter in the usual direction. If any sign of tool marks are seen these can be removed with file and sand paper, and the work is polished before receiving the spiral cutting. See that the chuck is screwed up tight, otherwise it may come undone at the wrong moment.

Another point in this work is this—instead of spiral flutes, straight flutes, and other patterns can be cut down the vase or other object. Of course, in such cases the work is turned by the dividing

apparatus as required. Spiral cutting can be done after the fluting, and a double pattern is the result —very effective.

In these, and the preceding instructions, it will be seen that the worker has the option of finishing the form prior to ornamentation by either the ordinary fixed tool or the fly-cutter, but in the case of the former, the exact centre of the tool must coincide with that of the tool that follows, specially if a tool in the drill-spindle is used; the reason is, where one tool follows another in the same path, the height of centres must coincide.

A vase black-stained and polished and then spirally or otherwise cut would produce a most striking effect. Clean cutting, however, would have to be done, as no sand-papering can be allowed, as will be apparent.

Templates of old back-saw blades can be utilised for altering or moving a tool to its next cut, and refixing the stop by grinding the blade to the exact width of the tool used. They will answer admirably in the absence of micrometer marked screws on the slide-rest. They are interposed between the rest and the stop, and the stop readjusted. Hence all cuts will be the same and equal the width of the tool.

African blackwood often reveals nasty flaws and cracks just where they cannot be cut out or removed. The pulverized turnings, mixed with glue, answer admirably for filling up these, which, when dry will turn up clean and not show a trace of the original flaw. Little tool accidents to finished articles can be similarly treated.

Small circular brushes revolved in the chuck prove

efficient tools for polishing bead and other patterns, which cannot be reached if the work is rotated.

Truing work which has got shifted.—Sometimes a piece of work attached to the 3-jaw chuck becomes untrue, and has to be reset. Usually a scriber is used, and no end of tapping, this way and that, is tried till true. Now, try this way: *Re-grip* in chuck sufficiently tight to hold the work, and under it place a long bar of round steel, and *as a lever* place an end behind against the lathe bed and bring up the fore end till it just engages with the work, and apply *gentle and quick pressure* till it runs true, and *immediately withdraw.* It is done in an instant. Then tighten jaws.

A similar method can be used to get serviette rings to run true when pushed on a mandrel of boxwood, etc., for finishing. Push them gently on and then take a smooth hammer and *tap the far side* quickly and keep the eye in line and suddenly the ring will *go true.* If a bit loose on the mandrel a piece of tissue paper will add extra grip. When removing, do not force the ring off, but place between two wooden blocks—the chuck hanging between—and gently tap out with a small hammer.

CHAPTER IX.

A Simple Lathe Overhead Gear.

As promised in an earlier chapter, I now include a description of a simple overhead gear which any amateur can fit to his own lathe. The drawings and description are reproduced, by permission, from *The Model Engineer* of December 14th, 1911, and I may, perhaps, add that other types of overhead gear have been described at various times in that journal. The gear now described was designed specially for a Drummond lathe, and the complete arrangement of lathe and overhead is illustrated in Plate XXI. The same gear can, however, be adapted to suit any make of lathe, and it has the advantage of being both easy and inexpensive to construct.

Plate XXII is a sketch of the ceiling arrangement, the principal feature of which is a hinged wooden rod, or tension-bar, which is attached to a strong wooden bracket, by means of an ordinary (for preference, wrough iron or brass) butt hinge. This tension-bar may be 3 ins. or $3\frac{1}{2}$ ins. by about 1 in. thick, say of pitch-pine, or ash. Oak would be good wood, but correspondingly heavy to work; while at a pinch ordinary straight-grained deal without knots would answer the purpose. It is slotted through from top to bottom for a distance equal to the amount of horizontal traverse of the slide-rest, which slot should be

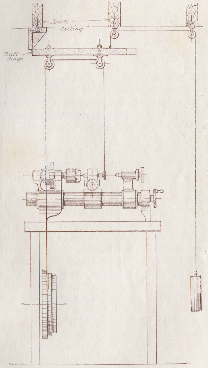


PLATE XXI.
Simple form of Overhead Gear fitted to Drummond lathe (see Chapter IX.).

(Facing page 104.)

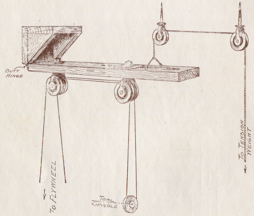


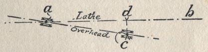
PLATE XXII.
Details of Overhead Gear shown in Plate XXI.

of such size that it will take the shank of an ordinary ironmonger's double-pulley screw fitting, having cast-iron wheels. The shank of the fitting should be shortened, and the largest size screw-thread possible cut thereon, and a nut fitted, while two square thin plate washers on either side of the wood bar distribute the pressure of the nut. A similar double-pulley fitting is fixed permanently to the bar at the left-hand end, immediately over the fly-wheel, with ordinary washers. For those who wish to diminish "clatter," it would be as well to remove the pins from the pulley fittings, and broach or reamer the wheels all to size and truly round, and re-fit turned steel pins, or silver steel rod of the right size, a nice running fit. At the same time add small oil holes to the pulleys. The bracket shown may be of deal, glued and nailed together. Single-wheel pulley screws of a smaller size carry the tension line, on the end of which is hung such as an old clock weight well down near the ground. Good clothes line will do for this latter purpose, but the largest size clock gut will be better. The single pulleys do not need new spindles, but if similar pulleys can be obtained, minus the wood screw, but with a countersunk plate for attachment with two or more wood screws, so much the better. In attaching the hinge to the bar, it will be noted that it is screwed end on to the grain, which in some woods will not matter, but in such as deal or pitch-pine the screws may not hold. Having marked where the screws come, with centre lines, by means of a centre bit, bore traverse holes through the thickness of the bar, about 1 in. from the end (so that the nearest edge of hole is 1 in.

from end) on these centre lines, and drive in round plugs, into which the points of the screws pass well in, side grain on. The plugs, if tight, need not be glued, but should be flushed off on either side of bar. In attaching the tension line to bar, place two strong screw eyes into same on either side, clear of the square washers, and straddle the gut or line clear of the nut. As an alternative, make a strong mild steel wire bridge by bending the wire to an angle and turning the free ends into hooks to engage with the eyes, and knotting the line at the apex.

In the complete view in Plate XXI it should be noted that the three points of suspension are made on three separate joists, instead of along one, a point worth consideration in view of the flimsy nature of construction in some dwelling-houses we all know of. To find the position of joists, if the ceiling is at all dirty (the household powers do not usually include our workshops in the year's estimates when considering the annual spring clean), these generally show up with whiter lines, failing which, by gently tapping the ceiling with a light hammer, the deadness of sound will soon account for the run of the joists above; also, the floor above, if any, will give a key to the same by the nail heads in floor boards, the joists running at right angles to boards. In screwing the work to ceiling, see that all screws are sufficiently long to pass right through the lath and plaster well into joists to avoid a very obvious accident. The best and cheapest form of belt is round leather, say 3-16ths in., which may be jointed with fine steel wire, such as a needle, which has been thoroughly annealed. If the

tension arrangement does not give sufficient play for all purposes, it may be necessary to make up with a short length of belt, capable of fairly rapid removal, in which case use gut hooks and eyes. The position of attachment of tension line is probably about the best, giving as it does, a mean position for the leverage due to weight, and the effect on adjustment of belt for a given movement of the weight. The final point to consider is the best position for overhead taken on plan, and in relation to centre lines on lathe. The fixed pair of pulleys must be vertically over the driving wheel and lathe headstock, to allow the belt to clear all obstructions, and in referring to the small diagram here shown, it will be demonstrated that from this point, *a*, the line of overhead should diverge from centre line of lathe slightly towards the operator. In



this figure, *a b* is centre of lathe, and *a c* that of the overhead, and the amount of divergence as indicated by the distance *c d* is arrived at in this way: *c* is the position of the second pair of pulleys, when in the centre of slot, and the distance *c d* corresponds to about half the feed in traverse of the tool post on lathe, from which it will be seen that *c* is nominally vertically over a mean point for position of revolving cutters. This latter must be set out by the intending user, and is obviously dependent upon the type of

revolving cutter used, and the most general position it will occupy on the lathe. The distance will probably be about 2 to $2\frac{1}{4}$ ins., but in the case where a fairly lofty room is being used (don't forget, the greater the height the longer belt wanted, and, perhaps, the bar being nearer celling, the more protracted the stroke of tension apparatus) it may be possible to mount the appliance in line with the lathe.

APPENDIX

NOTES TO PLATE IV.—*Stops and Chucks.*—(1) and (2) Small stops for top-slide with binding screw and adjusting screw for setting the cuts, shown in position. (3) Long stop for the back of slide-rest saddle. The two screws fix it to back of saddle and the long screw engages with cross-slide and regulates depth of cuts as cylinders, etc., and the positions of other arrangements where the slide has to be replaced in the same position. The author has lately removed this long screw and bored the hole out and fitted a long *plain* rod, which fixes with two *set* screws made in top over hole. This allows of *quicker* adjustment, and is not so likely to shift. (4) Bell chuck made from an old tricycle wheel, spoke-holes left to illustrate. This screws on the plug-chuck like the plugs (see Plate XVIII.) It is shown with a boxwood plug fitted as a screw chuck for soft wood. (5) Small chuck made from the hub of an old perambulator wheel, the binding screws shown being tapped through the spokeholes. The jaw is a slit to admit of flat metal, which has to be shanked. Screws also on the plug-chuck. Four binding screws securely hold the work. (6) Bell chuck, made to fit the same fitting as (5).

NOTES TO PLATE X.—*Cutters: General Remarks.*—Two things apply to all the ornamental cutters, viz., a sharp edge and a polished edge. In the course of manufacture tools are oftenest shaped with the file, which leaves scratches upon the edges of the tools. Sharpening merely does not remove these, and, although they do not appear to the naked eye, they are distinctly visible upon the work in the form of scratches. It is an axiom that all tools should leave the work polished and clean. Now polishing removes these, and enables the scratches to be seen and to be polished out. Too much attention cannot be given to this, and no one is more conscious of this than the author, who, in often hurrying on to get all the specimens done for this work, has left some of these blemishes behind. The

tools shown are not specimens of finished workmanship, therefore, for the very reason just stated.

Cutters are made either from cast steel or silver steel, preferably the latter.

Many shapes can be filed up from the round or flat, but for those necessitating forging, the author has got quotations from Mr. Milnes, of Bradford, for blanks to be supplied, from which the worker can quickly get any tool he requires. These must then be hardened and tempered, and, when polished, are ready for use. For the hardening process the author has got a long piece of round $\frac{1}{2}$ in. iron, forged to a spoon shape at one end, into which the tool is laid and heated up, and tipped out into the water when a bright red is reached. Heat enough, but not more than enough. The caution often leads to underheating, in which case the tool is not hardened at all.

In Plate XVIII a grinding jig is illustrated, made by the author for small irregularly-shaped tools, and it is explained in the notes. Plain tools can be sharpened in the fashion described by Mr. G. Crump, in *The Model Engineer*, June 18th, 1908, but for the sake of those who have not back numbers the thing is reproduced and will be self-explanatory. Hollow tools can be ground and finished on iron and brass laps and fed with oil stone and cocus powders. The laps are merely long tapers revolved in the lathe. They could be made to run in the jig mentioned if the same were supplied with a female centre to take the point of the taper. This jig, being at back end of lathe, is to hand, and is not in danger of sending grit into the lathe working parts—a thing to be avoided!

Special Remarks.—It is wrong to suppose that it is necessary to possess many dozens of cutters. It is far more advisable to have one or more of a kind, for the obvious reason that if one breaks in the middle of a piece of work—a rare occurrence, but possible—it can be replaced, and the work proceeded with. Moreover, the having a ready-sharpened tool will enable a man pushed for time to go straight on instead of stopping for the grinding process. It is always advisable in deep cutting to go all over the pattern with the final cut with a freshly-sharpened tool, which must be set exactly as before, especially in materials which take the edge off quickly.

A most important thing next to remember in the making of tools, from the diamond point drill to the most intricate step drill or other cutter, is to keep the edge which follows the cutting edge clear of the work. In a chisel-edge tool the cutting is on the end and sides, and if the edge is not straight, but slightly angular or rounded, the result is unsatisfactory. Moreover, the following edge should not drag round against the work, rubbing up the surface already cut clean by the cutting edge. For this reason, and the difficulty of being so exact as to avoid it, the author strongly recommends Mr. Lukin's suggestion of cutting away half the tool, but it must be cut dead to the centre. The remarks on this point made in the notes on the medallions will make this clear. If, however, the tool is made, and one edge is found slightly farther from the centre than the other, then revolution in the opposite direction may effect a better cut. But only certain tools can be revolved either way, such as chisel and diamond ends. These cannot either when cranked!

A little practice will clear all this up, and the old adage proved, that an ounce of experience is worth a pound of theory. Get your tool to cut cleanly and no criticism can be made upon it!

I must now go into particulars briefly concerning the various cutters. For clearness the author's few cutters are grouped as follow:—(1) Roughing out cutters; (2) Smoothing cutters (which are slide-rest tools, and fixed while the work revolves against them); (3) Drill-spindle cutters, or "drills"; (4) Eccentric frame cutters; (5) Universal cutter frame cutters; (6) Running down cutters for making shanks on tools and studs. These latter tools were used to "shank" the ivory beads let into bases of vases in the Frontispiece. There must be no play in the drill spindle, and there must be no end-shake; yet there must be absolute freedom. Where a large drill-spindle is possessed and can be used for this work, a very handy arrangement is that of fitting one taper piece with a large hole in its fore end. Into this are fitted interchangeable tool-holders or cutter-holders, and these can have through them holes of various sizes, into which shanks of different sizes will go, and can be fastened by a screw. Thus, when cutters are made of various sized steel bars, there is no necessity to reduce the material for a stem.

The initial work of making these small holders would be fully repaid in the long run in this way.

NOTES TO PLATE XA.—*Tools and Cutters.*—Standing tools are: (1) Hand-graver. (2) Roughing out cutter. (3) "Conqueror" holder. (4) Author's home-made holder for 3/16ths stuff with graduated fitting in end for setting tools to a definite angle. The flange is removed, it fixes with two screws on side, and is reversible. (5) Three flat bead cutters, mentioned in the text (by Stanley & Co.). (6) Two running-down cutters (or hollow mills) one at each end of frame of small cutters. (7) Another flanged holder with left-handed cutter fixed with pin, as described in "Metal Turning," by Percival Marshall. (8) Right-handed tool of same kind, with solid shank. (9) The slide-rest tool, used to cut the bead round ivory bases of vases in the Frontispiece. (10) ∠ Tool mounted in handle, to cut out rings, as described in the text. (11) Circular-ended hand-tool, for curved surfaces and ends of serviette rings. (12) ∠ Tool for cutting out large rings, etc., and undercutting. (13) End mill for grooving metal and wood; the tool with which the grooves in the frame above were cut out. Three styles of cutters. Rows *a a* Drill-spindle cutters; *b* Fly-cutters; and *c* 3/16ths cutters to fit in the holder for slide-rest. (14) Top frame of cutters for eccentric cutter frame, showing five blades in the grooves and one fixed in frame in position. The round tool is a portmill of small size for small round holes for studs, etc.

NOTES TO PLATE XI.—*Drill-spindle* (*large*), *vertical slide, etc.*—(1) Drill-spindle (large) showing the gearing removed and strewn about, viz., the two-speed pulley (on left), and ring and spindle bearing under it; and the worm and tangent screw, on right side of photo. (2) The vertical-slide to which this is sometimes attached (see text). (3) On two taper fittings are shown a circular saw and a carborundum grinding wheel. If a small wheel of this kind were fitted to the small jig, described in Plate XVIII, the same could be used in conjunction with guides for shaping up the tools instead of filing them, if fittings of various angles were made—a suggestion that will need no definition. (4) Three various tapers are shown, all fitting this spindle. The small pulley was added by the author—made from a piece of a broken machine stand. (5) The fitting next the circular saw is the arrangement for setting the vertical slide horizontally.

NOTES TO PLATE XII.—*Examples of Serviette Rings.*—Reading left to right the rings are of the following materials: 1, 2, 4, 6, 9 are of blackwood. (1) Basket pattern. Each end is of a different design. This ring is in three pieces, made up of otherwise waste rings from other things made. (2) is lined with plush. The pattern is difficult and is worked on the eccentric chuck, and the crescents are six in number, of which there are three rows. The eccentricity is set out so that the tool placed at the end of the work is seen to perform its in and out work to form the crescents. It is difficult to describe in few words, and is a pattern better left alone till the worker understands his eccentric chuck! (4) Basket pattern, finer tool, less penetration and more cuts round. (6) Cut with a step tool of three steps, getting the second round in the middle of the first and the third in same position as first; got by giving half the distance on the count wheel before starting to cut, and then returning to the original position. (7) Bead tool in drill-spindle. (8) A hollow tool with two narrow chisel ends at sides of same. Work edged with holly rings, plain, the ornamentation being done on the blackwood. Holly will not take them. (9) Spiral work and the segment engine used to give the spacings for the hollows with tiny bead centres. (3) Cocus. End cut with eccentric circles. Basket pattern centre. Same cuttings as 1 only not spiral. (5) Ivory. Same pattern as 8, only with a larger radius tool.

NOTES TO PLATE XIII (on front cover of book).—*Vases and Boxes.*—The specimens here illustrated are the author's earliest productions. (1) The large vase was his first piece of work. That particular object was made in box and plain turned mahogany bands at base, at the top of the first column, and under the bowl. The whole is drill-spindle work. Flutings can be done with either this instrument or the fly-cutter in universal cutter frame. The ends, however, are different, as, in the first case, they go up to the finish, and can be worked up to the shoulder; but with the latter tool, the revolution of the cutter would dash into any shoulder, or other protusion, and cut it away. But when

members are made separately either can be used, as a clear course over the ends is secured. The style alone must then decide which to use. (2) The small vase was made from cocus and box, the bowl and foot of the former and the stem of the latter. The twisted design on stem was cut with the fly-cutter set at an angle to give this effect. (3) The box under the small vase is of boxwood, with ornamental lid and simply fluted round with a wide flute cut with the fly-cutter in universal cutter frame, cutting vertically. This is another way of fluting, but the cuts must of necessity be shallow. If, however, the cuts are carried deep enough to meet in a sharp edge the effect is not that of fluting, but a cut made in the same way as for basket pattern carried right across. It will also be seen that the sides of the tool finishing right and left leave a rounded cut, but a chisel tool, in place of a round-nosed tool, would have left it square. (4) The little small white box is of artificial (vegetable) ivory. It is a bold pattern. A nut in its natural state is shown on the right. They go in the larger sizes to about 2 inches long. Very clean cutting. (5) The white ring is an ordinary purchased bone serviette ring (cost 5d.), with a few cuts made worth 2s. 6d.—half-an-hour's work! All done with one tool at one setting. (6) Lid for box with dome centre, cut with the tool frame set at 45 deg., as elsewhere described. Twelve eccentric circles surround the dome. (7) Cocus box. Lid interlacing circles. Body of box shows basket work. A little of the sap was left on outside to give a varied effect. This is of much lighter colour. (8) Cocus box left plain to show grain of wood, which, unfortunately, does not appear in photo.

Notes to Plate XV.—*Medallions* (read left to right).—Row I. (1) Blackwood. Inlaid with holly studs made with leather punch and driven in. Centre of walnut. Ten interlacing circles. (2) Bone. Cut from a meat bone that had been cooked, showing what can be done with waste material, a piece of the bone left on to illustrate. Twelve beads. Centre of fine interlacing circles. (3) Blackwood. The outer cuts are done with the tool set at an angle, causing it to cut only on its side, and during half its revolution. The beads were then cut in, and finally the twelve interlacing circles and the small Turk's cap in the centre. The Turk's cap is cut by causing the drill cutter to pass the centre in its revolution, instead of its being all to the side of the centre.

Row II. (4) Superlays of box and ebony with the top ring of walnut. Dome-shaped. (5) Boxwood. The five holes cut with a step-drill, the first step passing through. The beads cut with a bead-drill with two cutting edges, and the centre—barley corn pattern cut with a one-angle cutter in the eccentric cutter frame. The one-angle cutter is like the diamond cutter reduced to its half, and one form can have its edge on the left side and the other the right. These produce quite different patterns and revolve differently. (6) Red fibre—procurable from Messrs. Mosses & Mitchell, of Golden Lane, E.C. The eighteen small crescents cut with the side of tool, as the deeper cuts in Row I. (3). The eighteen "petals" cut with round-nosed tool in universal frame set to cut horizontally. The centre cuts are really the same crescents placed so closely together as to form another pattern. This material is not noticed in the text, and here needs a little introduction. The material works very cleanly and cuts well, and is very tough and hard. There is no jerking owing to its uniform texture, and the cuttings come away in long strips. There is a slight tendency in certain patterns to leave a "burr," but if a flat piece of hardwood covered with fine sandpaper is placed against the finished pattern while the same is revolved, it will take this away and not injure the pattern. Sharp angles do not do well in this material, but a great variety can be selected without trying these and courting disappointment. The usual brush with a suspicion of Moeller & Condrup's "Rapid" Polish on it will give the final touch required.

This red fibre is useful for the making of cog-wheels and pulleys, and will be very handy for the same in some of our home-made tools, etc. It is procurable in sheets of varying thickness in black, red and grey; also in rods. It is fairly light, and therefore is reasonably cheap. A piece 12 ins. square by $\frac{1}{8}$ in. weighs 14 ozs. and the price is 1s. 6d. per lb.

Row III. (7) Holly, cocus and box. The swallow-tailed crescents were cut with the tool at an angle, but made to cut in the opposite direction, *i.e.*, in the opposite way to 3 and 6. The beads were produced by means of a cutter filed away past the centre so that in its revolution the centre is missed. Had

the tool been filed to exactly the centre a simple concavity would have resulted. And here is the place for a remark on this point. Mr. Evans says that in shaping these drills (after the shank has been made) they should be put in their own working position, and by means of a graver, a centring dot placed as a guide for filing. Now I find this requires a microscopic eyesight, and just when you get to the dot you feel afraid to transgress for fear of getting beyond its centre. But a sure way is to revolve the drill when you are near the spot and notice if there is a central dark spot. If so, more must be filed away. A piece of white card placed on the lathe-bed will assist matters. Now go carefully and reduce till no dark appears. If you go too far a gap, or light, will be seen. This will widen as you go beyond the centre. Now this is useful, as if you happen to spoil a drill for a clean concavity you can get it into shape to cut a bead with a flat top of any size the drill will admit. The above remarks apply only to the reduction of the cutting part, not to the first operation of reducing down to half—a thing which is done in all cases before the shape is started on. See on the drill, Plate X, for further remarks on this question. (8) The centre medallion—Blackwood and pearl. Basket pattern on blackwood, cut with short radius tool in universal cutter frame. Eighteen cuts in circle, four rows Centre pearl, forty-five cuts with tool in drill spindle, as above described, of small radius and filed a little beyond the centre, leaving a small spot bead in the centre.

The eight circles are cut (diamond cranked drill in the drill spindle or diamond cutter set to required radius in the universal cutter frame) to a definite pattern by omitting four cuts of the series, that is, instead of cutting them all, $7\frac{1}{2}$ revolutions of the tangent screw are made, or the correct number of holes passed on the count wheel, and this is repeated, and then 15 revolutions are counted, and two more at $7\frac{1}{2}$, and so on. The author is giving $7\frac{1}{2}$, as his worm-wheel has 90 teeth. If, as in some lathes, there were 180 teeth, just 15 turns would be required to cover the same distance. Hence all specific numbers here are for the 90-tooth wheel. The above variation in patterns can often be adopted to assist in the increase of design, and at the same time to lessen and hasten the work. Pearl plays

havoc with the edges of tools. Also heating the tool quickly and drawing the temper of both tool and worker. Care should therefore be used! (9) Boxwood, with studs of holly, and inlays of blackwood powdered and mixed with glue, as elsewhere directed. The outer pattern was cut with an end-mill in drill spindle, and the work actuated by the worm and tangent screw. Penetrate tool and carry cut towards centre against back stop. Then rotate tangent screw, having determined the number by calculation—and then work back again to the starting stop. Hence a groove is cut. Then the screw again revolves the work a given distance, and the second cut is made, and so on round. Any irregular shapes of this kind can be filled with the compound, where solid wood would give unbounded trouble; and no one can tell the difference! A method of calculating for such designs is given in the text of the work.

Row IV. (10) Box, rosewood and blackwood. The flat-studding is done by inserting pins around the periphery and afterwards reducing to the half-section, and then the white studs can be let in, and the centre ring, either of solid wood or the powder and glue. In this case it is the latter, just for example's sake. The white studs will be seen to be slightly out of truth. This was done after the work had been removed, and the replacement wa, done by the eye. As it is difficult to exactly fix work like this, the author thought of the "Zero" method, which he has written on elsewhere—a method which makes the above kind of thing impossible. (11) Cocus and pearl. The crescents were cut by the same tool as those in 3 and 6, but at a less angle, and the beads as 7, with less penetration. The mother-of-pearl centre shows again the method of interlacing circles and the one prominent circle was the first one cut, which took the point clean off the tool, and the author did not observe this till the whole was finished. (12) Boxwood and blackwood dust (pestled in a mortar and sifted) and glue. Here is an impossible pattern without the latter compound. This variety can be very greatly increased with good effect. (13) Black fibre. The same remarks apply as to 6 in regard to material. The pattern is an instance of deep cutting so far as the beads are concerned. The centre is cut with a tool described

as a one-angle tool (see above). (14) Bone. A piece of the same shin bone obtained from the culinary department (see 2). Cut in a similar way to 6. (15) Blackwood. Snake pattern. This curious effect is got by moving the tool a certain distance nearer the centre after each cut is made. The only drawback is it is impossible to begin and finish the pattern well. Hence it is, in that sense, imperfect. A radius drill was used in cutting it.

NOTES TO PLATE XVI.—*Ivory and Blackwood Vases.*—We must begin with the bases. A plain circular base of blackwood which needs no comment, ornamented by a series of small ivory studs of fancy design. The method of procedure in making these will now be explained, and will answer for all other cases of a similar kind. All the studs are alike in every way. Several ideas were tested, but the following is the best, and easiest, and quickest too. First get a square piece of wood of exactly the distance doubled between the top of tool-rest and lathe centres. If the distance is $\frac{3}{8}$ in. (as in my case), then a piece of beech or box $\frac{3}{4}$ in. square by 6 ins. long is cut. Place this in slide rest, truly square with lathe bed, and mark its position, or make a flange so that it can always be replaced correctly. Next run up against a drill in the s.c. chuck, which, revolving, will cut a hole of the required size outside size of bead. Now remove and square the hole. Feed further across and make another, and leave that round, you can then insert square stuff in one, and round in the other. Now get your material cut up to fix either of these holes in exact lengths. Place the first in its hole and the piece on the rest. Feed up to a running-down cutter (described in Plate X), and the projecting piece will be shanked. Work to a stop, and the shanks will be all of the same length. When all are done, one after the other, mount a piece of boxwood on a plug and face up to a disc, say 2 ins. by $\frac{1}{8}$ in. or 3/16ths in., and if the ivory studs number 12, bore 12 holes equidistant in it and quite through—those of the size of shanks a tight fit. Now place all these studs round one in each hole, and with the drill spindle finish their outer ends one after the other. All that remains is to polish them, push them out from the back, and place them in their final positions in the article. Of course, a running-down cutter can be used to turn down the

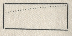
projection before the pattern is put on the end, if square stuff is used.

NOTES TO PLATE XVIII.—*A Grinding Jig.*—This little appliance is a small lathe in reality—a model lathe—a dead-centre lathe. It is fixed in the hand-rest socket at the rear end of lathe and driven by the overhead. It can remain there ready for use at any moment. It is adjustable for height, and along the length of the slot of the rest socket also, both of which movements allow of getting the belt to the right tension. It is instantly removed if in the way. The photograph will explain the manufacture. The right-hand centre withdraws, and a binding screw fixes it. Thus different mandrels and wheels can be put on. These wheels are parted off a boxwood turned block by the circular saw. This is centrally bored up. The wheels are finished in position, and the cutter, they are to sharpen and polish, used to form them. Then they are coated with the abrasive and polishing materials. Glue or shellac can be used. This tool, designed for the above purpose, can also be used to turn up small things in model work—small pulleys, or wheels, or pivots, etc., etc. Hence it will serve a double purpose. The guides for the tools are not shown. They merely guide the tool along the metal rest and are made of the size and right angles to present the cutters to the wheels. If the grinding and polishing wheels are made in pairs, side by side, with a division cut between them, they can be used together without having to change for the finishing operation. If three are required, then they can be mounted in the same way. But be careful in the coating not to get the materials mixed. Coat the polisher last. Other means of sharpening on long tapers are spoken of elsewhere, which can be used also on this machine.

NOTES TO PLATE XIX.—*Spiral and Curvilinear Apparatus.*—Here a piece of spiral work is shown in position. The cramp and hand vice shown were used in this case, as the template had to be shifted and no holes were then available. This suggestsed that instead of drilling holes all along this bar, less work would be occasioned by having two small strong cramps to hold the templates, then any fine adjustment could be made which holes would not allow. The template cannot be seen, but its position

can be understood. The difficulty of taking this photo against a bright window will be appreciated. The over-head strap is seen, as is also the universal cutter frame fixed to it. The design is not the prettiest, but is an example—done this way to show up the idea. Spirals are not elegant if the tools cutting them destroy the contour of the work, as in this case. The cross-feed screw of saddle is seen to be absent, and the hand-wheel to which it is attached.

Notes to Plate XX.—*Fancy Whistles, Spiral Box, Etc.* The two whistles shown are specimens of work that at once become popular with the younger members of society if they are presented to them. The *modus operandi* in regard to their production is as follows: The boxwood mouth-piece is made first. This is shaped and bored right through, and then polished and parted off. A shoulder is left on the back end, and a collar in either ivory or bone fitted and glued on. The piece is then reversed, pushed on to a turned peg, and got to run true, and a recess cut in the end to receive the blackwood end. This is made and ornamented and glued on. Then the end which is chucked is turned by the whole being fitted on the above peg, with the centre up to the back end. The mouth-piece plug is then turned and a flat filed in a slanting direction thus :



to make a "windway." The slope is towards the front end and narrowest where the wind escapes. "The mouth" is cut down with a fret-saw, and finished with a file. A round pea is put in before the whole is glued up to give a series of quick sounds instead of one long one.

The small box in vegetable ivory is another specimen of work in this kind of material. For small work no better substance could be utilised, but nearly every nut has a fracture which has to be filled up with either "Fortafix" or plaster of Paris, or any substance that will dry white.

The box with spiral is produced with a coarse setting of the change-wheels—any from 2 to 4 to the inch serving the purpose—

and is a single cut. By arrangement of work and tools a double-start or treble-start thread could be cut. This is the simplest to do. Observe, no curvilinear apparatus is used as it is straight work. In any case, however, where a straight-lined taper is being produced for ornamentation, and the taper is too long to be cut with the slide-rest swivelled, a long straight-edged template can be used with the above, and the slide-rest and saddle moved along it. The saddle, of course, moves straight, but the top slide with the cross-feed screw cut, and the weights attached moves in accordance with the template whichever way it is fixed. In cutting these tapers get the small end at the back end, the reason being that if at the other end, a fly-cutter will not pass out, the frame fouling the chuck even if small.

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